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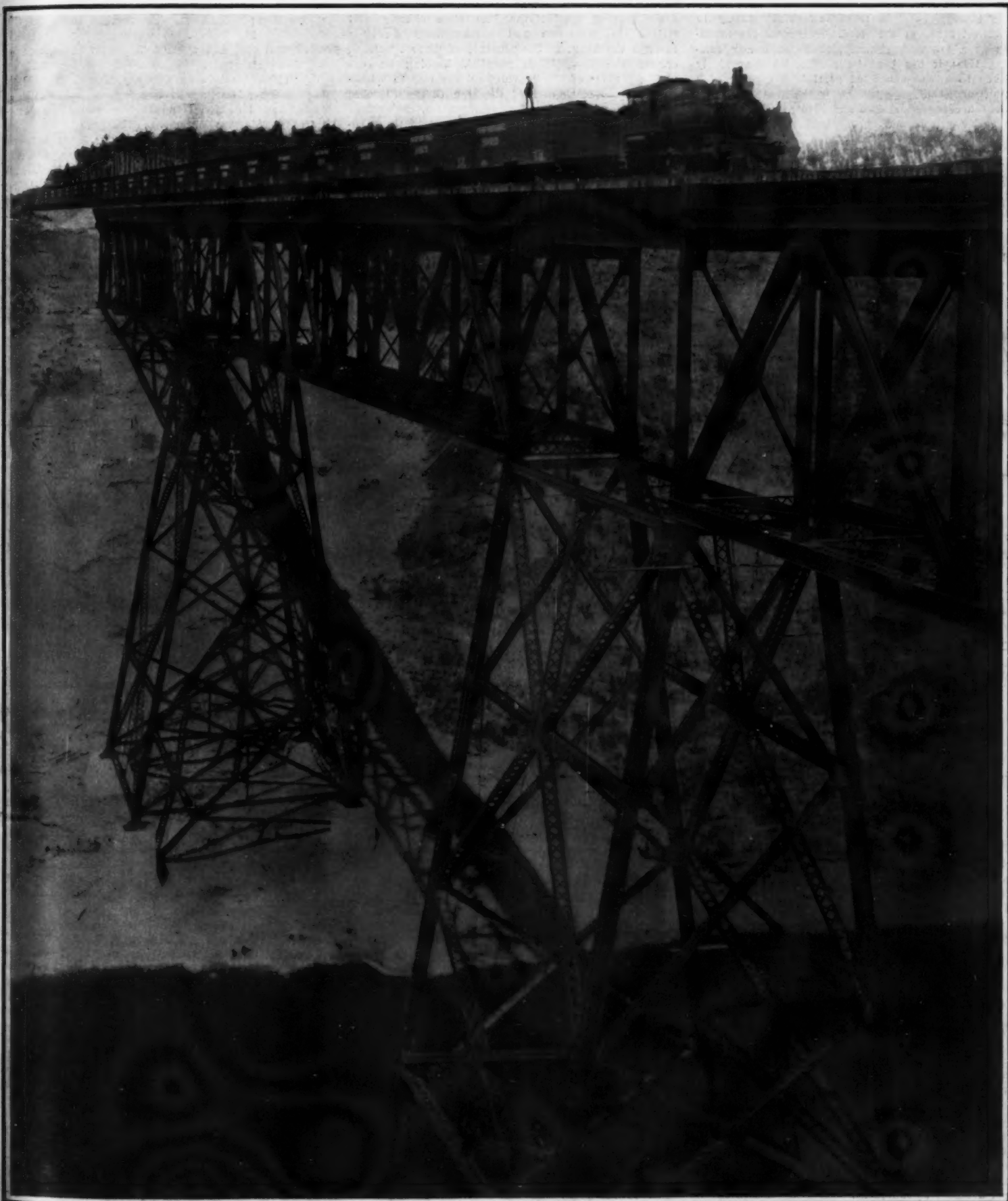
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THE EASTERN HALF OF THE GRAND TRUNK TRANSCONTINENTAL LINE IS BUILT THROUGH A COUNTRY THAT IS VEINED WITH NUMEROUS RIVERS, THE CROSSING OF WHICH  
NECESSITATED MUCH COSTLY STEEL BRIDGING.

THE GRAND TRUNK TRANSCONTINENTAL CANADIAN RAILROAD

# The Grand Trunk Transcontinental Canadian Railway

## A New 3,590-mile Road with Light Grades and Easy Curves

ACTIVE progress is being maintained on the construction of the new line that is being built across Canada from the Atlantic to the Pacific, and if the present rate of progress is preserved, it will be completed and opened for traffic well within the scheduled date of 1914. This undertaking is important from many points of view. In the first place it is the greatest length of railroad which has ever been conceived and put under construction in one complete scheme, since it is 3,590 miles from terminus to terminus. It is the first line to be thrown across the North American continent from ocean to ocean under one management, thereby being a transcontinental railway in the fullest sense of the word. It crosses the mountains at a lower maximum altitude than any competing line; it has been built at a more northerly latitude than was conceived possible a quarter of a century ago, the route laying for the greater part of its length between the 48th and 54th parallels; and it has easier grades and curves than any line on the continent.

The undertaking owes its inception entirely to the bold progressive policy of Mr. Charles M. Hays, the president of the Grand Trunk Railway system, who conceived the idea during the short period he was in charge of the Union Pacific for Mr. Harriman. When the scheme was submitted to the Canadian government for approval and support, it was warmly supported, and tangible financial assistance was promised. The government, however, in deference to public opinion undertook to construct and retain one-half of the line, subsequently leasing it to the Grand Trunk Pacific

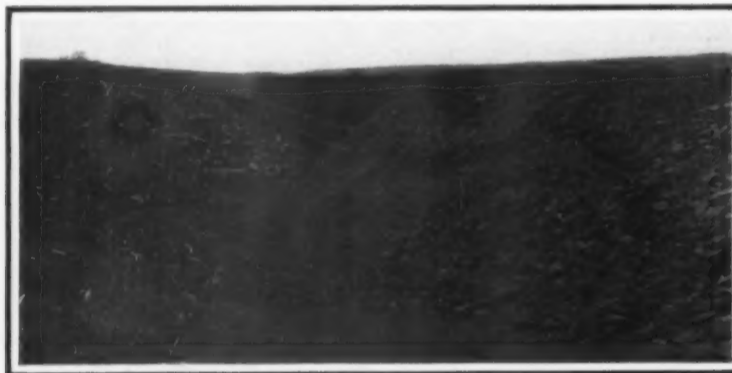
through from the latter point to the Pacific coast, a distance of about 1,785 miles. It was also stipulated that the line should run entirely through Canadian territory, which restriction compelled the surveyors to make a wide detour around the north of the State of Maine. The line follows the frontier of this State pretty closely for some distance, and then runs roughly parallel with the St. Lawrence, though some distance inland to Levis opposite Quebec.

The railway is to be carried across the St. Lawrence River from Levis to Quebec by the great cantilever bridge which is shortly to be re-commenced. After leaving Quebec the line rises sharply and strikes in a north and northwesterly direction through the heart of the province of Quebec until it crosses the forty-eighth parallel, keeping on the northern slope of the "Divide" all the way to Winnipeg. The construction of the line through Quebec and Ontario has bristled with difficulties, the greater part of which, however, were in regard to the sending forward of supplies and material. When the country was entered by the surveyors it was practically unexplored, and the maps which existed were found to be so erroneous that they were discarded.

The country is densely wooded and is intersected with numerous wide rivers which have cut deep channels through the soft soil. The soil is heavily soaked with water, muskeg consequently abounding, with here and there large stretches of swamp. In addition to the rivers there are innumerable creeks, lakes, and shallow stretches of water which required diverting or draining, and in order to secure a per-

which is only 500 miles to the south, and the manufacturing centers of the States. For this reason Cochrane is certain of a great future. There are 1,600 people in residence; the town has been permanently planned, and buildings have sprung up on all sides. A large union passenger depot is being erected, together with roundhouses, sidetracks, repair shops at this junction, for the Temiskaming line will carry the whole of the passenger and freight traffic between Montreal, Toronto, Chicago, and our great manufacturing centers to Prince Rupert for Alaska and the Orient.

When the Temiskaming line reached Cochrane the contractors at once set to work driving the transcontinental east and west of the latter point, and at the present moment 150 miles of line are laid on either side. That being driven eastward is meeting that section advancing westward from Quebec, while the westward section is advancing toward that coming eastward from Winnipeg. The road, 100 feet in width, has been cleared the whole distance between Winnipeg and Quebec, some 1,344.39 miles, and the grading is well advanced toward completion. On this section no timber trestles whatever are being used, the steel work for bridges being erected as the track advances, while all culverts are of concrete construction. The roadbed is well built and protected, and the track is being ballasted to a depth of eighteen inches. The quantity of steel required for bridging aggregates 26,000 tons, exclusive of the Quebec bridge, over the whole 1,304 miles, of which 13,000 tons has been delivered, and has already been erected



SOLID EMBANKMENTS ARE CONSTRUCTED BY BUILDING A TRESTLE BRIDGE AND DUMPING THE ROCK THEREFROM BY THE TRAINLOAD.



ON THIS SECTION OF THE ROAD, EAST OF ST. LOZANE, THE GRADING WAS DONE BY RUSSIAN DOUKHOBORS.

### THE GRAND TRUNK TRANSCONTINENTAL CANADIAN RAILROAD

Railway for a term of fifty years at a rental equivalent to three per cent on the constructional cost, such interest, however, to be waived for the first seven years while the country traversed was being settled and developed, the company undertaking to defray maintenance expenses during this period only. On the mountain section, which is perforce the most difficult from the engineering point of view, and consequently the most expensive to build, the government is contributing to the cost to the extent of twenty-five per cent. Up to the end of the last Dominion fiscal year \$132,400,000 had been sunk in the enterprise, of which total \$72,400,000 represented the government's expenditure, while the balance of \$60,000,000 had been found by British investors.

Through the courtesy of the president the correspondent of the SCIENTIFIC AMERICAN was provided with facilities last summer for traveling over the whole works, including the untouched section of some 800 miles through British Columbia which had to be negotiated by pack-horse, involving ninety-one days on the trail. When the scheme was sanctioned it was decided that construction should be carried out upon a high standard, in accordance with the requirements of a modern railway to meet the exigencies of heavy fast traffic for several years to come, thus avoiding that re-alignment and reconstruction, which is so severe a burden upon American railways to-day. For this reason it was stipulated that the ruling grade should not exceed four-tenths of one per cent per mile against east and west bound traffic, and that curves should not be sharper than five degrees. Timber trestles also were to be omitted, unless it was intended that such should be afterwards filled in to form a stable embankment.

The government section is 1,804.84 miles in length and extends from Moncton in New Brunswick, which is the Atlantic seaboard terminal to Winnipeg, the Grand Trunk Pacific carrying the construction

perfectly stable embankment, not only were wide side draining ditches necessary, but laterals had to be freely driven to carry the water away from the side trenches.

When the work was first commenced the main difficulty confronting the contractors was the transportation of their plant from the nearest centers of civilization to the respective constructional sites. In summer time the country was absolutely impassable to animal traction owing to the prevalence of the muskeg. Large fleets of canoes, and in some cases shallow draught steamboats and barges were requisitioned to make avail of the waterways as far as practicable, and when the innermost points possible by such means were reached, the plant had to be "cached" until the winter, when it was hauled in on sleighs over the frozen snow. Roads had to be cut and trails driven in all directions to provide communication between the route of the line and the numerous depots for food and material which were established. Owing to the character of the country, a small army of dogs had to be secured for hauling the lighter material in on sleds, and half-breed porters, owing to their superior physique and stamina, secured for carrying and driving purposes.

These conditions affected more or less the whole undertaking through these two provinces, but was of more serious import in the eastern and western sections of Ontario and Quebec, respectively, as this part of the country was the most remote from civilization. In this case, however, the Ontario Provincial government extended far-reaching assistance by pushing their railway, the Temiskaming and Northern Ontario Line, 114 miles beyond its terminus at Englehart to the point where it would cross the Transcontinental. At the junction a new town has sprung up—Cochrane—and a new tract of excellent arable land 16,000,000 acres in extent, opened up. This move brought the new route into direct touch with Toronto,

or is upon the works. The construction has provided employment for an average of 12,000 men. The total quantity of 80-pound rails which will be required upon this division for the main track and sidetracks totals 280,000 gross tons, and the ties number 3,000 per mile of track.

Westward of Winnipeg the Grand Trunk Pacific has completed and inaugurated its service upon the 793 miles of line to Edmonton. This section is laid over the rolling prairie, with the result that grades and curves are of the easiest description. The track, in regard to standard of construction, coincides very closely with that prevailing in Great Britain, so that high traveling speeds will be possible. By the new service provided between these two important Canadian cities, the traveling time is reduced by over six hours on that offered by a rival line, and when the roadbed has settled down a twenty-hour service between the two points will be possible to express trains. The prairie section does not offer any great engineering features beyond the heavy steel bridges over the broad deep rivers which are of excellent construction. Where massive timber viaducts have been erected such are only temporary and are to be filled in when the line is opened up to permit material to be hauled cheaply from any available point. This work is now in progress, and within a few years of the completion of the whole line all trestles will have been either filled in, or if this is impracticable, replaced by permanent steel work.

In addition to the main line, the railway company built a spur 188.8 miles in length stretching from Fort William in a northwesterly direction so as to strike the transcontinental line 255 miles east of Winnipeg at Lake Superior Junction. The provision of this short link, however, provides the railway company with their own outlet on Lake Superior, and at Fort William they have erected their own facilities for shipping on the Great Lakes to United States

ports. These terminal conveniences include a huge grain elevator which when complete will be of 40,000,000 bushels capacity; the first unit of 10,000,000 bushels has just been completed.

The prairie section extends for 126 miles west of Edmonton to Wolf Creek, a tributary to the MacLeod River. This point is the official commencement of the mountain division, as the section to the coast is called, inasmuch as it has to negotiate the Rockies and the coastal continuation of the Cascades. At Wolf Creek the track is at an elevation of 2,700 feet above the sea level, and yet the highest point reached by this railway is only 3,720 feet in the Yellowhead Pass, where the Rockies are traversed. The pass, however, is about 100 miles west of Wolf Creek, and from the latter point the grade rises steadily and continuously the whole distance, but only on an average of 10 feet to the mile, which ascent is almost imperceptible. Curiously enough, the surveyors found that the Rockies could be threaded at an elevation of only 3,720 feet. The country between Wolf Creek and the foothills of the Rockies, something like 100 miles distant, is steadily rolling, covered with dense forest, the greater part of which, however, has been swept over by fire. The line runs at an angle to the mountain range, the snow capped peaks of which are kept in full view for about 100 miles, since in order to preserve the grade the track is kept at a high level on the hillsides overlooking the river valleys.

The mountains are entered by the Athabaska River Pass, the track when it strikes this waterway following its southern bank. The earthworks between Wolf Creek and the foothills, while heavy, are mostly con-

The ascent up to this point from Wolf Creek is very gradual, enabling the limited ruling gradient of 21 feet per mile to be easily retained and with plenty to spare. On the western side, however, after rolling away with an almost imperceptible fall for some distance, the land drops very suddenly for some 22 miles, and here the engineers have not yet succeeded in locating other than a pusher grade of 1 per cent. against eastbound traffic along the upper reaches of the Fraser River, which is met just after the pass is traversed.

Though the railway cannot offer such examples of spectacular engineering as the Rockies in Montana and Colorado, yet the greatest achievement lies in the avoidance of these very obstacles, so as to provide an almost level route, with no stiffer grades and sharper curves than are to be met on the open prairie. To railway operation this is of far-reaching value. For instance, a locomotive of the consolidated type weighing 107 tons would haul on a perfectly level track 3,868 tons. On a 1 per cent grade, however, it could handle only 810 tons; but on a 4/10 of 1 per cent. grade, such as is provided on the new transcontinental line, its hauling capacity would be almost double—1,596 tons. It must not be thought, however, that because the engineers have taken avail of the natural physical conditions for carrying the line through a low pass, that the country presents no scenic attractions. As a matter of fact the Yellowhead is one of the wildest stretches of the range, many of the peaks towering well above 10,000 feet. From the grade may be seen the Fiddle Back clump, all the crests of which are over 10,000 feet. Pyramid Mountain, 9,000 feet; Mount Gelkie, 11,000 feet; Mount Peelee, about 10,000

the coast has occupied about six years, and it may be the best described as one continual succession of blasts the whole way. Over 10,000,000 pounds of powder, representing a value of more than \$1,000,000, have been expended in this work, and over 2,000,000 shots of varying calibers have been fired. To build one mile of track alone occupied no less than fourteen months' continuous work, there being solid rock cuts from 150 to 200 feet in depth. The restrictions regarding grades and curves caused construction to occupy considerably more time than would have been the case had the general American practice been followed, and has contributed to the expense of the work. It is computed that the first 100 miles from the coast, which is the heaviest division, has cost about \$150,000 per mile. But that the money has been well expended may be gathered from the fact that the first 60 miles is absolutely dead level, although it extends through the most mountainous stretch on the whole line. Moreover, the track is open for nearly the whole way, there being very little recourse to tunneling, as it was considered more satisfactory to excavate deep cuts.

The western terminus of the line is at Prince Rupert, where there is a magnificent natural harbor varying from three-quarters to one and a half miles in width by ten miles in length, and which, varying from 160 to 600 feet deep, with an unobstructed entrance three-quarters of a mile wide, is considered the finest harbor north of San Francisco. Here a hustling town has sprung up, and today boasts a population of over 5,000. The shipping of the port is on the increase, having risen from 700 to 10,000 tons per month in two years. The railway company has



ROCK FILL ADVANCING FROM OPPOSITE SHORES OF LAKE.



PARTY OF SURVEYING ENGINEERS CROSSING RIVER WITH MULE PACK.

#### THE GRAND TRUNK TRANSCONTINENTAL CANADIAN RAILROAD

finned to removal of common earth, there only being blasting here and there. The cuts are heavy, and at places the muskeg has proved a serious obstacle. At one point it became necessary to empty two large lakes and to sink massive corduroy mats of tree logs into the soft swampy bed to carry the fill, as the rock and earth when pitched pell-mell into the lake simply spread out under the superimposed pressure. "Gumbo" has also proved another serious obstacle. Being extremely hard, it could not be excavated without blasting, while in wet weather it was so slippery that the sides of the cut fell in as fast as excavated.

Shortly after the mountains are entered heavy blasting becomes necessary just below Jasper Lake in order to keep the line on the south bank of the Athabaska River. Here the mountain Roche à Miette breaks off very abruptly, leaving a perpendicular wall about 200 to 300 feet in height. This hump has been blasted away for a depth of twenty feet or so, the rock being dumped into the river to form the embankment and to protect it against the severe scouring action which results when this waterway is in flood. From the foot of Roche à Miette the line cuts straight across the valley along the south side of the river, which suddenly curving at right angles, is then crossed. Owing to the great width of the Athabaska at this point, a heavy, long bridge will be necessary. The north bank of the river gained, the valley of the Athabaska is followed over gently undulating country until the Miette River valley, running at right angles, is met. The line swings round to follow the Miette River, which is followed until near its source, when the line swings abruptly westward and reaches its highest point—3,720 feet above sea-level—at the Yellowhead Pass, and then enters British Columbia. The pass is about 1,000 feet in width, the valley being covered with a dense forest of large timber.

feet, and Mount Robson, 13,700 feet, the highest mountain of the Canadian Rockies.

When the railway strikes the Fraser River, just below its feeder from Yellowhead Lake, it follows this waterway for over 350 miles to Fort George. In the upper reaches the constructional work will be of a heavy nature. Owing to the crooked nature of the river, however, it will be necessary to swing the line across the waterway no less than five times, and each occasion will necessitate a bridge of considerable length, as the river varies between 300 and 500 feet in width above Fort George, which is destined to become an important railway center in the interior of British Columbia, situated as it is at the confluence of the Fraser and Nechaco rivers.

After leaving Fort George the railway takes a northwesterly direction, following the west bank of the Nechaco River through the valley of that name to Fraser Lake, another Hudson Bay post, and shortly after this valley is entered the Coastal range of mountains, the continuation of the Cascades, and finally reaches a more or less open valley leading into Hazelton, the head of navigation of the Skeena River, some 180 miles from the coast. The banks of this waterway on either side are towering, eternally-snowcapped peaks, the range being continuous on either side for the whole distance to the coast. The construction up this river has proved the most difficult part of the whole task from the engineering point of view. The mountain sides drop sheer into the water, and for 150 miles it has been practically side-hill excavation through solid rock, the contour of the river's banks being very broken. At the present moment although construction is in active progress throughout the whole length of this river section, the skeleton track is laid for only about 100 miles. The building of the grade for the first 100 miles from

blasted and cleared a spacious site whereon is to be erected a terminal depot, replete with all time and labor conveniences for the handling of passengers and freight between ship, shore and railroad.

That this railway is destined to exercise a far-reaching influence upon the movement of traffic across Canada, owing to its almost imperceptible grades and closer proximity to the Orient, is admitted on all sides. Moreover its physical conditions, combined with substantial construction, will render it the fastest line between Atlantic and Pacific. Its economic importance is also incalculable, as it traverses a country which is new, and the resources of which are practically untouched. In British Columbia a virgin territory, rich in mineral, timber and possessing excellent stretches of agricultural land, is being opened up, and the route cannot fail to have considerable influence upon our trade with Alaska, to which it will be the obvious highroad, linking it directly with our manufacturing and industrial centers, and involving a sea passage to Skaagway of only about 500 miles.

#### Oxygen and Mushrooms

The following is a singular way of removing oxygen from the air by the aid of a plant. Inside a glass bell-jar, suspended over water, is placed a mushroom, and sunlight is allowed to fall upon the plant. The mushroom absorbs the oxygen from the air in the jar, and the carbonic acid formed during the process is absorbed by the water, which gradually rises in the jar to one-fifth of its height. The mushroom now dries up; but its animation is only suspended, as may be proved by introducing beside it a green plant, when it will recommence to vegetate, being nourished by the oxygen exhaled from the fresh plant.

# Multiplex Telephony and Telegraphy—IV\*

## Electric Waves Guided by Wires

By George O. Squier

Concluded from Supplement No. 1854 page 38

It is noted from the tables submitted that capacities as large as hundredths of a microfarad were at times used, and in order to secure these it was necessary to join several of the air condensers of wireless telegraph pattern in parallel, adding their results. In like manner the inductances used were as high as three millihenrys in some cases. Fortunately, capacities and inductances can be easily constructed which at the same time preserve the continuously variable feature necessary for tuning purposes, and may have also compact physical dimensions; in fact in suitable designs for these frequencies these tuning elements may be even smaller and more compact than they now are for wireless telegraph practice. This is for the reason that in the case of electric waves impressed upon wires there are no high voltages such as are required in apparatus using an antenna. Furthermore, by properly designing inductances in accordance with the fundamental formulae laid down by Maxwell, it is evident that variometers suitable for this range of frequencies impressed upon wire circuits may be made extremely small and compact.

It should be noted that throughout these experiments not a single piece of new apparatus was designed or constructed, but the conventional apparatus as now employed in wireless telegraph engineering was adopted as a whole, although, as stated above, this apparatus could be very materially improved in the line of compactness of design for this range of frequencies.

Since no cases of high voltage were required at the transmitting end of the line, the same form of apparatus was used interchangeably for transmitting and receiving, whereas in wireless practice the transmitting antennae coils and condensers are very large in comparison with those used for receiving.

### TRANSMITTING IMPEDANCE AT RESONANCE BY THE AMMETER-VOLTMETER METHOD.

To determine the general character of the effective impedance of this line as the frequency is changed,

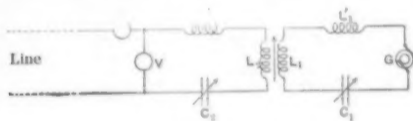


FIG. 19

measurements were made of the transmitting current and voltage as the frequency is varied from about 23,000 to 90,000 cycles per second. The circuit is shown in Fig. 19 and the data obtained are given in Table X which is shown graphically in Fig. 20. In taking these measurements, loose coupling was used and the tuning elements adjusted to resonance in each case. The voltmeter used was of the hot wire type of comparatively high resistance, and the ammeter was of the hot wire type of low resistance. At

resonance  $I = \frac{E}{Z}$  or  $Z = \frac{E}{I}$  where  $E$  and  $I$  are the

measurements given above, from which  $Z$  in columns 4 and 7 Table X have been derived. The curves Fig. 20 indicate a minimum effective impedance of about 87 ohms at a frequency of about 59,000, the curves being nearly symmetrical on either side of this frequency.

Attempts were made to make similar measurements for the line connected directly to the generator instead of inductively connected as above and working to constant voltage at different frequencies. In such cases the reaction between the resonant circuit of the line and the directly connected circuit of the generator armature was so marked and so sensitive to variation of frequency at resonance that it was found extremely difficult to make consistent measurements under these conditions. The marked superiority of loose inductive coupling between the line circuit and the generator enabled a study to be made of the line circuit *per se* without involving any reactive influence from the generator source.

It is noteworthy that with this cable line it was not possible to detect with certainty the reactive influence of opening or closing the distant end of the

line upon the transmitting voltmeter and ammeter readings, and, as noted above, the resonant curves at the transmitting end are practically the same for the distant end open or closed.

The presence in this line of two pairs of inductance heat coils at fixed points undoubtedly is sufficient to

TABLE IX  
DATA FOR SELECTIVITY CURVE OF TELEPHONE-CABLE LINE, RECEIVING END SHORT-CIRCUITED  
Frequency of generator constant at 53,000 complete cycles per second

| $m_1$  | $f$ | $\frac{n_1}{n}$ | $\frac{I}{I_0}$ |
|--------|-----|-----------------|-----------------|
| 72,000 | 50  | 1.374           | 0.278           |
| 69,600 | 60  | 1.310           | 0.333           |
| 66,600 | 70  | 1.255           | 0.388           |
| 64,700 | 80  | 1.221           | 0.444           |
| 63,200 | 90  | 1.194           | 0.500           |
| 62,500 | 100 | 1.180           | 0.556           |
| 60,500 | 110 | 1.144           | 0.611           |
| 59,500 | 120 | 1.123           | 0.667           |
| 58,700 | 130 | 1.100           | 0.722           |
| 57,900 | 140 | 1.092           | 0.778           |
| 56,900 | 150 | 1.074           | 0.833           |
| 56,300 | 160 | 1.062           | 0.889           |
| 54,800 | 170 | 1.034           | 0.945           |
| 53,000 | 180 | 1.000           | 1.000           |
| 50,800 | 170 | 0.956           | 0.945           |
| 49,700 | 160 | 0.938           | 0.889           |
| 48,800 | 150 | 0.921           | 0.833           |
| 47,300 | 140 | 0.892           | 0.778           |
| 46,100 | 130 | 0.870           | 0.722           |
| 44,500 | 120 | 0.847           | 0.667           |
| 44,100 | 110 | 0.832           | 0.611           |
| 42,200 | 100 | 0.796           | 0.556           |
| 40,400 | 90  | 0.762           | 0.500           |
| 38,900 | 80  | 0.698           | 0.444           |

$m_1$  Frequency of line circuit tuned to give dissonance with generator frequency.  
 $I$  Measured line current at frequency  $m_1$ , in milliamperes.  
 $n$  Imposed frequency of generator, constant at 53,000 cycles per second.  
 $I_0$  Maximum current in line circuit, tuned to resonance with generator frequency, 180 milliamperes.

cause at least partial reflections of the waves being propagated along the line. These heat coils, as stated above, each had a measured inductance of 4,400 centimeters at 70,000 cycles.

### RESONANCE CURVE AT RECEIVING END.

In the series of resonance curves, which has already been given, the observations were taken at the

TABLE X  
DATA FOR TRANSMITTING END IMPEDANCE AT RESONANCE OF TELEPHONE CABLE LINE, RECEIVING END OPEN AND SHORT-CIRCUITED, AT DIFFERENT FREQUENCIES

| Cycles per second | Line open |         |      | Line short-circuited |         |      |
|-------------------|-----------|---------|------|----------------------|---------|------|
|                   | Volts     | Amperes | Ohms | Volts                | Amperes | Ohms |
| 23,000            | 22.3      | 0.108   | 206  | 22.6                 | 0.108   | 213  |
| 35,000            | 19.1      | 0.112   | 169  | 16.3                 | 0.116   | 140  |
| 47,000            | 16.0      | 0.154   | 104  | 16.0                 | 0.153   | 105  |
| 63,000            | 15.8      | 0.178   | 88   | 15.8                 | 0.180   | 88   |
| 75,000            | 16.5      | 0.148   | 110  | 16.3                 | 0.148   | 110  |
| 90,000            | 23.8      | 0.138   | 172  | 23.5                 | 0.138   | 170  |

transmitting end of the cable line and no attempt at tuning was made at the receiving end of the line, it being the object to study first the line *per se* without terminal apparatus. The effects, however, of introducing tuning elements across the line at the receiving end are strikingly shown in Fig. 21, the data for

TABLE XI  
RESONANCE CURVE AT RECEIVING END OF TELEPHONE CABLE LINE, TRANSMITTING CURRENT CONSTANT AT 200 MILLIAMPERES AND 40,000 CYCLES

| Receiving capacity in microfarads in series with constant inductance | Received current in milliamperes |
|--|----------------------------------|
| 0.00292  | 1                                |
| 0.00354  | 1.8                              |
| 0.00422  | 3                                |
| 0.00462  | 3.5                              |
| 0.00470  | 3.4                              |
| 0.00508  | 3.6                              |
| 0.00579  | 3.8                              |
| 0.00606  | 3.85                             |
| 0.00623  | 3.8                              |
| 0.00748  | 3.6                              |
| 0.00870  | 3.4                              |
| 0.00973  | 3.2                              |
| 0.01067  | 3.0                              |
| 0.01337  | 1.7                              |

TABLE XII  
DATA FOR ATTENUATION-FREQUENCY CURVE AT RECEIVING END OF TELEPHONE CABLE LINE, SHORT-CIRCUITED THROUGH DUDDELL THERMO-AMMETER OF 171 OHMS, TRANSMITTING CURRENT CONSTANT AT 240 MILLIAMPERES

| Transmitting current in milliamperes | Received current in milliamperes | Frequency |
|--------------------------------------|----------------------------------|-----------|
| 240                                  | 4.90                             | 30,000    |
| "                                    | 3.80                             | 40,000    |
| "                                    | 3.45                             | 50,000    |
| "                                    | 1.5                              | 60,000    |
| "                                    | 0.5                              | 70,000    |
| "                                    | 0.3                              | 80,000    |
| "                                    | 0.3                              | 90,000    |

which is given in Table XI. In taking these observations a frequency of 40,000 was selected as fairly representative.

At the transmitting end of the line the current and frequency were kept constant throughout, and at the receiving end of the line only the capacity element of the tuning apparatus was varied, which caused a rise and fall of the received current, as shown in Fig. 21.

The inductance element of the tuning apparatus at the receiving end was kept constant throughout the experiment, so that the variables which are plotted in this curve are the actual observations taken and therefore represent exact conditions with no supposition as to derived results. It is noted that the magnitude of received current in this case can be easily multiplied nearly three times by simply adjusting the variable condenser at the receiving end, in a receiver arrangement selected at random.

### ATTENUATION CURVE.

To determine quantitatively the influence of variation of frequency upon the attenuation of the current transmitted over this telephone line the data given in Table XII were obtained, the curve for which is shown in Fig. 22.

In this experiment the transmitting current was kept constant at 240 milliamperes, the only thing varied being the frequency of the alternator.

At the receiving end the telephone line was short-circuited through a Duddell thermo-ammeter, which

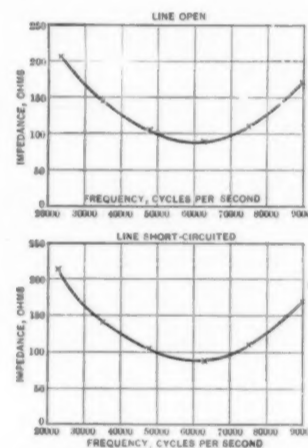


FIG. 20.—Impedance-frequency curve at resonance, transmitting end of telephone cable line.

is practically non-inductive with a resistance of 171 ohms. The frequency was varied between 30,000 and 90,000 cycles per second, and observations were taken at intervals of 10,000 cycles per second. The curve shows very strikingly the attenuation of the transmitted current as the frequency is increased. The values of the received current at 30,000 and 90,000, being about as small as could be read on the particular ammeter used, are not as accurate as the other readings, and this is indicated by the dotted part of the curve.

### SUMMARY.

Radio-telegraphy has no competitor as a means of transmitting intelligence between ships at sea and between ships and shore stations and on land it is also unique in its usefulness in reaching isolated districts and otherwise inaccessible points. To what extent it may be also developed to furnish practical intercommunication according to the high standard now enjoyed in thickly populated districts, it is not attempted to predict.

The foregoing experiments indicate that either the existing wire system, or additional wires for the purpose may be utilized for the efficient transmission of telephonic and telegraphic messages, and the former without interfering with the existing telephone traffic on these wires.

The fact that each of the circuits created by the use of super-imposed high-frequency methods is both a telephone and a telegraph circuit interchangeably, makes it possible to offer to the public a new type of service, which it is believed, will offer many advantages to the commercial world. This type of circuit should be particularly applicable to press as-

\* Presented before the Congress of Technology at the Fiftieth Anniversary of the Granting of the Charter of the American Institute of Electrical Engineers, Chicago, Ill., June 26th-30th, 1911. Copyright, 1911, by A. I. E. E.

association service, railroad service, and leased wire service of all kinds.

The experiments described should not be interpreted as in any way indicating limitations to radio-telegraphy and telephony in the future, for their present rapid development gives justification for great prospect for the future. It is rather considered that the whole

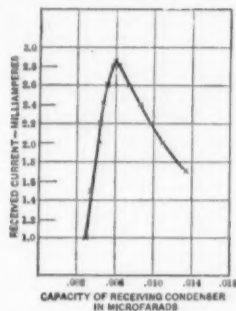


FIG. 21.—Resonance curve at receiving end of telephone cable line. Transmitting current constant at 200 milliamperes and at 40,000 cycles.

system of intercommunication, including both wire methods and wireless methods, will grow apace, and as each advance is made in either of these it will create new demands and standards for still further development. We need more wireless telegraphy everywhere, and not less do we need more wire telegraphy and telephony everywhere, and, again, more submarine cables. The number of submarine cables

connecting Europe with America could be increased many times and all of them kept fully occupied, provided the traffic were properly classified to enable some of the enormous business which is now carried on by mail to be transferred to the quicker and more efficient cablegram letter. That time will surely come when the methods of electrical intercommunication will have been so developed and multiplied that the people of the different countries of the world may become real neighbors.

Accustomed to the methods of transmitting energy for power purposes by means of wire it is a matter of wonder that enough energy can be delivered at a receiving antenna from a transmitting point thousands of miles distant to operate successfully receiving devices. The value of a metallic wire guide for the energy of the electric waves is strikingly shown in the above experiments and it furnishes an efficient directive wireless system which confines the ether disturbances to closely bounded regions and thus offers a ready solution to the serious problems of interferences between messages which of necessity have to be met in wireless operations through space.

The distortion of speech which is an inherent feature of telephony over wires should be much less, if not practically absent, when we more and more withdraw the phenomena from the metal of the wire and confine them to a longitudinal strip of the ether which forms the region between the two wires of a metallic circuit.

The ohmic resistance of the wire as shown can be made to play a comparatively unimportant part in the transmission of speech and the more the phenomena are of the ether, instead of that of metallic

conduction, the more perfectly will the modified electric waves, which are the vehicle for transmitting the speech, be delivered at the receiving point without distortion.

It has been shown that the phenomena of resonance, which are met with in so many different branches of physics, exhibit very striking and orderly results when applied to electric waves propagated by means of

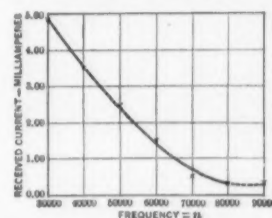


FIG. 22.—Attenuation-frequency curve at receiving end of telephone cable line, short-circuited though. Duddell thermo-ammeter of 171 ohms, transmitting current constant at 240 milliamperes.

wires. By utilizing this principle it has been shown that the receiving current at the end of the line may be built up and amplified many times over what it would be with untuned circuits.

The tuned electrical circuit at the receiving end readily admits electromagnetic waves of a certain definite frequency, and bars from entrance electromagnetic waves of other frequencies. This permits the possibility of utilizing a single circuit for multiplex telephony and telegraphy.

## Heat-insulating Efficiency of Vacuum-jacketed Bottles

### A Physical Study

By A. A. Somerville, of Cornell University

THE vacuum-jacketed bottle for preserving liquids at a temperature other than that of the surroundings has become an article of common use, and, in a qualitative way at any rate, the principle on which it depends is well known to all. There are three ways in which heat may be transferred from place to place, tending to equalize temperatures. They are: convection, conduction and radiation. Heat interchange by convection (air currents) may be prevented almost completely by closing the mouth of the vessel. Radiation is reduced to a minimum by silvering the walls of the vessel, since it is well known that a good reflector is a poor radiator. Finally, the function of the vacuum jacket is to reduce to a very small amount the heat loss by conduction, since a vacuum is the best heat-insulator known. These, then, are, qualitatively speaking, the principles on which are based the vacuum-jacketed bottles placed on the market under various names. In none of them is heat trans-

fering the bottle each time to a different depth, beginning with a depth of one inch, and each successive run being made with the bottle filled one inch deeper with water at 32 deg. F.

When there was only a small amount of water in the bottle a given amount of heat transferred from the outside to the inside would cause a greater rise in temperature than the same amount of heat when there was more water in the bottle to be heated.

The curves in Fig. 1 represent these changes of temperature as indicated by the recording instrument. The numbers on the curves correspond to the depth in inches to which the bottle was filled. That is, number one represents the rather rapid rise of temperature when there was only one inch of water in the bottom of the bottle. Number two represents a smaller rate of increase when there was twice as much water used as in number one.

It is to be noted that when it was seven inches deep the rate of rise of temperature was a little greater than that for six inches depth, and when the bottle was full or eight inches deep the rate of rise of temperature was greater than when there was only three inches of water used.

In Fig. 2 a curve is drawn using for axes the rate of change of temperature for a period of six hours and the depth to which the bottle is filled in inches.

This curve clearly shows that in view of conduction over the neck of the bottle this should not be filled to within more than one or two inches from the top. The minimum point of the curve shows that the highest efficiency is attained with a layer six or seven inches deep. Or, as has been said, if a person is going to take a cold bottle on a picnic he ought to fill it and then take a little drink before starting.

### Electric Stage Lights

THE electric light equipment of a modern stage calls for the establishment of a tremendous plant. The stage lights of the Metropolitan Opera House, for instance, number more than 2,600. There are 700 white lights and 468 each of amber, red and blue.

These are operated by a switchboard provided with a double set of busbars and two master switches for each color of light. By means of these switches the lights can be shut off at will on either side of the stage, so that the operator can darken one side while illuminating the other with light of any of the four colors desired.

Some strikingly realistic effects are produced in this manner, notably sunlight and moonlight. Besides the fixed lights enumerated above, there are more than fifty movable lights in single lamps and groups for the production of special effects. These include two sciopticons by which snow and many other wonderful illusions are produced.

Included also are fourteen lens boxes or chasers, useful accessories for sudden and brilliant illumination of the whole stage or any part of it, concentration of light on a single performer or a group of performers, and especially for weird effects. The chaser is provided with a revolving diaphragm, by the operation of which a rapid succession of rays can be thrown upon the performers, with the surprising effect of apparently multiplying the number. The same instrument is also used to produce rapid alternations of color.

### Ventilating the Simplon Tunnel

RECENT reports to the Swiss Government note some interesting facts with reference to the ventilation of the great Simplon Tunnel.

The change from steam to electric traction has not altered the arrangements for ventilation. The two entrances, at Brieg, Switzerland, and Iselle, Italy, are

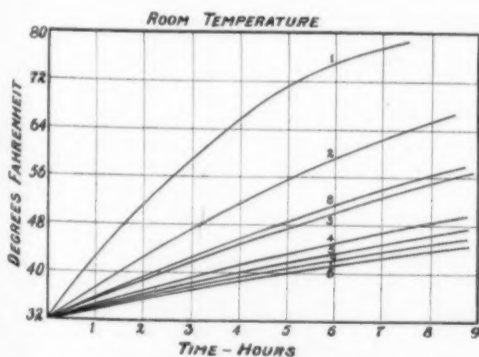


FIG. 1.—Curves Showing Rate of Heat Loss With Time When the Vessel Is Filled to From One to Eight Inches Depth.

fer entirely prevented, for then we should have a constant-temperature vessel. Quantitatively, we may inquire just to what extent a given vacuum bottle does prevent leakage of heat. Most firms make claims as to the efficiency or time rate of change of temperature in their particular product. An interesting test has just been made by the author, different from any that has been described before.

A thermometer was connected to an automatic temperature and time recording device. This thermometer was placed in a bottle of the kind described, the bottle filled with water at the temperature of melting ice, and then as the temperature rose slowly the automatic recorder drew a time-temperature curve extending over several hours and ranging from ice to room temperature. This operation was then repeated,

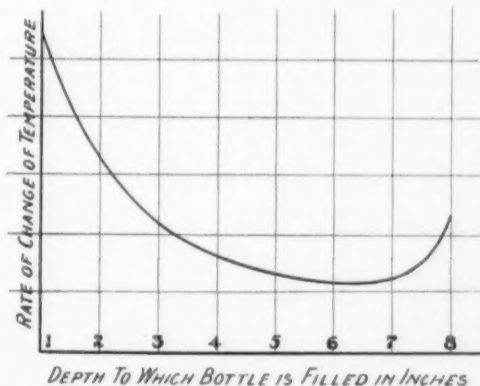


FIG. 2.—Curve Showing How the Rate of Heat Exchange Depends on Depth of Filling. There Is a Minimum at About Six or Seven Inches.

covered, except at the moment when a train enters or leaves, by huge cloth screens, which are automatically raised and lowered by electricity. Two electric fans, nearly ten feet in diameter, and making three hundred and fifty turns a minute, drive air into the tunnel at Brieg at the rate of one thousand liters per second, and a similar installation at Iselle draws air from the tunnel. The air pressure on the screen at Brieg amounts to four kilograms per square meter, while on the screen at Iselle the pressure is twelve kilograms per square meter.

# What Constitutes Superiority in an Airship—II\*

## An Analyses of Existing Types

By Commandant Paul Renard<sup>1</sup>

Concluded from Supplement No. 1854 page 48

### III.

THESE general considerations are not mere digression from the question which we are considering to-day. We must not lose sight of them if we wish to estimate things clearly. Do we not often hear the remark: "Of what importance are dirigibles or aeroplanes? They do not travel as fast as railroad trains; they have much less carrying capacity than boats; would it not be worth while rather to perfect the time-honored land or maritime means of travel than to search for a new method of transportation?"

If aerial navigation did not differ in its essential properties from these other modes of locomotion known from the most ancient times this presentation of the case would be entirely rational, but when men pursue so indefatigably the conquest of the air and the public follows its progress with such interest, it is not because they hope to discover in this way the means of possessing in a higher degree the qualities of speed and capacity desirable in any vehicle, it is because of qualities found alone in aerial navigation. If this were not so the conquest of the air would still certainly be an important question, but it would not be worth all the efforts that it brings forth and the excited interest that it arouses.

We can not actually realize what is before us, but there is to-day an idea latent in every mind that the investigation into aerial locomotion is not a vain caprice of mankind, but springs from a deep and instinctive feeling that extraordinary changes are impending in the conditions of humanity.

We must now go a step further into the detailed study of the qualities which we have enumerated and choose the most important.

The first quality which I mentioned is the faculty of ascending to the greatest possible height. The means for accomplishing this end are different, according to whether the machines are heavier or lighter than air. In the first case it is necessary to have at your disposal a motive power greater than that necessary to sustain and move the machine in a horizontal plane. It is therefore a question of the power of the motor.

If however the airship is a dirigible balloon the motor does not come into consideration. It is only necessary to throw off a definite weight of ballast, and the greater this quantity is for a given balloon the higher it will ascend. Besides the weight of the motor and the mechanism itself and the weight of the fuel and other supplies and of the passengers, arrangements must also be made for a supplementary weight that can be sacrificed. It is not enough to increase the volume of the gas envelope in order to increase the dispensable ballast in the same proportion for the altitude attained does not depend on the absolute amount of ballast thrown off but on the ratio of this weight to the volume of the balloon. If, for example, with a balloon of 1,000 cubic meters an altitude of about 2,300 meters should be attained by releasing 250 kilograms of ballast, to attain the same altitude with a balloon of 2,000 cubic meters capacity not 250 kilograms, but 500, must be thrown off. If the weight of the airship itself, the motor mechanism, the supplies, and the passengers increased proportionately with the volume of the gas envelope, we would always have the same proportion of ballast and could ascend no higher in one case than in the other. This, however, is not the fact, for large balloons can carry a larger proportion of ballast than small ones and it is with these that high altitudes are most easily attained. The altitude is therefore to a great degree a question of volume.

It may be remarked that if lighter motors for a given power are provided or greater power for a given weight—in other words if the weight is reduced, there would be more dispensable weight, more ballast per horse-power, and, consequently, a greater capability of ascension. It is also evident that to attain an extreme elevation the weight carried should be reduced as much as possible. Thus the number of passengers should be reduced to a minimum and little or no extra material carried. By doing this, in the case of a dirigible, the dispensable ballast can be increased to the extent of the economy which has been realized in the rest of the equipment. In the case of an aviation machine if its total weight is diminished and, consequently the expenditure of motive power necessary to sustain the machine, the excess power available for attaining altitudes is thereby also increased. To sum

up, in all air-ships, of whatever kind, altitude may be attained with a facility corresponding to the power available for a given weight, but with dirigibles the principal method of reaching higher altitudes is by increasing the dimension of the gas envelope.

An aerial voyage can be prolonged as long as supplies remain available, whether the airship be lighter or heavier than air. The most important of these supplies is fuel for the motor and the accessory lubricating oils, the weight of which is comparatively small. In dirigibles there must also be a supply of ballast proportionate to the length of the voyage. The quality of duration is therefore a question of transporting capacity, and the methods of obtaining it are the same.

The distance that can be covered is evidently proportional to the duration of the trip, and is also proportional to the absolute velocity of the airship. We have just considered the duration; as for the absolute speed, it is a quality that must be considered by itself. We have, therefore, as regards distance only one thing to keep in mind, and that is, it is obtained by combining the means used to attain duration and velocity.

As already stated, absolute velocity is a resultant of two velocities, that of the wind and that of the airship, with the wind we can do nothing, but the individual velocity is another matter. It may be remarked that if the individual velocity should be less than that of the wind, the machine would not advance but would recede more or less from its point of departure. Such a machine, however, would not be dirigible and would not deserve the name of "airship." We mean to consider here only devices really dirigible, that is, those whose velocity is greater than that of the prevailing wind. In this case, whether flying against the air or with it, the absolute velocity will increase with the individual velocity. Let us suppose that the wind blows 50 kilometers an hour. The airship with an individual velocity of 60 kilometers will make 10 kilometers an hour against the current and 110 with it. If it has an individual velocity of 70 kilometers, it can travel 20 kilometers an hour against the wind and 120 with it. In either case it is evident that the absolute velocity increases with the individual velocity. One can even demonstrate mathematically that when an airship describes a closed circuit corresponding approximately to the form of a circle or a regular polygon, whatever may be the velocity and direction of the wind the one that possesses the greatest individual velocity will have the greatest average absolute speed around the whole course.

As we can not affect the velocity of the wind, to seek to increase the absolute velocity is in fact to seek the greatest individual velocity. We have just seen how desirable this quality of speed is in itself. Without it dirigibility is impossible; and the greater it is the more frequent are the occasions when we can travel in all directions and the greater will be the distances covered. Speed is, therefore, in respect to importance, the principal quality in an airship, without which it is but the plaything of the winds, and it is toward the improvement of this feature that all efforts should be directed.

How may this individual velocity be obtained? In dirigibles all resistance to forward movement must be diminished as far as possible; this is accomplished by appropriate design of form. This form must be permanently maintained, powerful motors must be provided, driving good propellers. To sum up, every improvement which can be devised with regard to dirigible balloons should be directed principally if not solely toward the increase of their individual velocities.

The same is true with regard to aviation apparatus, but in this direction the difficulty is much less, for because of their light design they offer much less resistance to forward motion than the dirigibles, condemned to drag along their enormous bags filled with hydrogen. For a given motive power therefore the former can attain much greater speeds than balloons, as experience has superabundantly demonstrated.

However that may be, for the one or the other the individual velocity is a question of motive power, and since in an airship only a limited weight can be allowed for the motor, this must have as great a specific power as possible; in other words, the weight of the gas engine should be reduced as much as practicable. The question of individual velocity thus depends on the lightness of the motors. This motive power must, furthermore, be utilized to the best possible advantage, which can be done by proper propellers. The resistance to forward movement must be diminished, and this can be accomplished by careful design. The airship must also be stable in all directions—horizon-

tally, longitudinally, or transversely—for yawing, pitching, and rolling, apart from the wearying effect on passengers and the dangers they may present, are formidable obstacles to the best speed. When a dirigible moves sidewise it presents an enormous surface to the air of a shape deplorable from the point of view of resistance, and the speed is diminished to an inconceivable degree.

One can almost sum up in a word what can be said about individual velocity. It is this, that for an airship to possess this quality in the highest degree it must be endowed with all the others.

There remains now the carrying capacity. Here the question appears in quite a different light, according to whether the apparatus is lighter or heavier than air.

With a dirigible it is simply a question of the volume of the balloon. It must not be thought, however, that by increasing indefinitely the volume of the gas envelope that the carrying power of an airship can be increased without limit. To enlarge volume means to increase the fabric surface and this will demand greater strength in a large balloon than a small one, which will increase the weight of a square meter of the envelope and accordingly result in a double cause of increase in the total weight. This will also be true with regard to the suspension cords and all the material constituting the dead weight.

It can be demonstrated that in balloons of different volumes this dead weight increases nearly as the fourth power of the linear dimensions; that is, more rapidly than the volume. Thus in a balloon of twice the volume the dead weight will not be multiplied by 2 but by 2.52, and with triple the volume of the dead weight will be multiplied not by 3 but by 4.33 and so on. In spite of this unfavorable circumstance, however, we may say in the limits of practice, that the carrying capacity increases with the volume. It increases also with the lightening of the motors, for if the motor is lighter for a given power the economy in weight so realized can be used to increase the weight carried; in general, however, it is preferred to profit by this lightening by increasing the motive power and consequently the speed.

In a dirigible the total ascensional force is the product of the volume of the balloon by the lifting power of a cubic meter of gas. This latter quantity depends entirely on the specific gravity of the air and of the gas employed. As long as no gas lighter than hydrogen can be found there can be no hope of a change in the present conditions, and even if such a gas should be discovered, we should always be limited by the weight of a cubic meter of air, 1.293 kilograms. This figure represents the extreme limit of weight that a cubic meter of the gas could lift, if it weighed nothing. However, a cubic meter of pure hydrogen weighs only 0.090 kilogram; a cubic meter of this gas therefore raises a weight of 1.203 kilograms, and even if there existed a gas of zero density only 90 grams per cubic meter would be gained over the lifting power of hydrogen.

Consequently, it is true at the present day and always will be, that the total lifting power of a balloon can be increased only by an enlargement of its volume.

In an apparatus heavier than air this total ascensional force is again equal to the product of two factors; in this case however, it is the surface of the sustaining planes, and the supporting power per square meter. To increase this total ascensional force it thus becomes necessary to increase one or the other of these factors.

Theoretically, the dimensions of the sustaining planes can be increased, but in practice it is difficult, for these surfaces become much heavier as they increase in size and thus absorb a large part of the increase of ascensional power attained thereby. If this is carried still further the weight of the sustaining surfaces can be increased to such an extent that all the benefit of the increase in size is lost, and even more. We should, therefore, endeavor to increase the carrying power per square meter of the sustaining planes.

This carrying power may be increased partly by an increase in the sustaining quality of the bearing surface, and it is research in this direction that practically leads to the perfection of devices heavier than air. It is a question of form, dimensions, and orientation which must be taken up in detail. This problem constitutes in reality nine-tenths of the problem of aviation.

In another way the load that can be carried per square meter of sustaining surface in a given appara-

\* Translated for the Smithsonian Institution's Annual Report from *Revue des Deux Mondes*, vol. 54, November 1st, 1909, pp. 181-199.

<sup>1</sup> The Wright aeroplane is now provided with a tail, or rear horizontal rudder.—Ed.

thus, increases with the available motive power. The greater this power is in comparison with the weight of the machine the larger may be the load imposed on each square meter of sustaining surface. The increase is not proportional, but it is rather rapid, as may be shown by a few figures. If an aeroplane provided with a 25-horse-power motor can carry 10 kilograms per square meter, the same aeroplane with a motor of 50 horse-power can carry 16 kilograms; with a 75-horse-power motor 21; and with a 100-horse-power motor 25 kilograms per square meter.

There is one very interesting point to note here, and that is, for a given aeroplane the capacity per square meter varies with the velocity. Let us suppose that our aeroplane with a 25-horse-power motor and carrying 10 kilograms per square meter, makes a speed of 60 kilometers per hour. When it is provided with a motor of 50 horse-power, which will permit it, as we have just seen, to carry 16 kilograms per square meter instead of 10, its velocity will be increased. It will no longer be 60, but 76 kilometers per hour. In the same way, if it has a 75-horse-power motor due to which its carrying capacity increases to 21 kilograms, its velocity will at the same time reach 86 kilometers. Finally, with the motor of 100 horse-power and a load of 25 kilograms per square meter it will have a velocity of 95 kilometers.

The individual velocity and the carrying capacity therefore increase with the power of the motor; nothing of the kind occurs with dirigibles.

However that may be, whether dirigibles or aviation apparatus are concerned, the carrying capacity is dependent on the lightness of the motors and the general perfection of the whole device; but these features have a much greater effect in the heavier than air system than in the lighter than air. In dirigibles there intervenes in this question a preponderating element, that of the volume of the gas bag whose influence dwarfs all others. This element does not exist in the aviation devices.

We have still to examine stability in all its forms, but, as we have already seen, this property is indispensable if we desire to attain an individual velocity of any magnitude whatever. There is, therefore, no necessity to analyze it in detail. We will simply remember that a rapid air-ship is necessarily stable.

#### IV.

From the foregoing the conclusion may be drawn that the different qualities which an air-ship may possess are not independent of one another but may be reduced to two fundamental properties, the individual velocity and the carrying capacity. The first of these qualities, the individual velocity, is highly desirable in itself, for without it dirigibility is impossible. Furthermore, it is the only means by which we can increase the absolute velocity, which is of such practical importance. Finally, the absolute velocity is one of the factors determining the distance that can be covered in a single flight. When the individual velocity is increased, for the same reason both the absolute velocity and the distance covered are increased. If we also add the consideration that the possession of this speed necessarily implies the possession of stability in all directions, we must conclude that in it we have a quality that is essentially fundamental.

The carrying capacity of such a machine can be measured by the amount of weight of every kind which it can carry in excess of the weight of the air-ship proper, its motor, propellers, and all the parts indispensable to its operation.

Given this weight it can be used in different ways. It can be employed in transporting a number of passengers or a considerable weight of merchandise. In the form of ballast it helps to attain the greatest altitude, and thus contributes to the duration of the aerial voyage. In the form of fuel supply it assures the dura-

tion of the voyage, thus affecting one of the two factors entering into distance covered.

Individual velocity can not be present in a high degree if the property of stability is not also present. This permits of the attainment of an absolute velocity which coupled with duration of voyage goes to make up distance traveled. The carrying capacity has no relation to stability. It can be utilized either for its own sake or to attain altitude, or to prolong the voyage and thus contribute in increasing the distance traveled.

These different qualities may therefore be divided into two groups, those dependent on the individual velocity and those on the carrying capacity. As for the distance traveled, it is a common resultant of the two groups, for it is the product of absolute velocity by duration of flight, qualities belonging to the different groups.

If we wish to obtain a synthetic idea of the value of an air-ship, it is by the ratio of the distances covered that their merit should be measured, but this quality is only the product of two others—the absolute velocity and the duration of the voyage. These two factors may play a varying rôle in the final result.

The factor of duration is certainly less important than the velocity. To obtain duration the machine need not even be dirigible; a simple free balloon can possess this quality, while up to the present time it is the spherical balloons which have made the longest uninterrupted voyages, so that while recognizing the valuable index which the distance traveled affords in the estimation of the merit of an air-ship, still, of the two elements which go to make it up, we must attach more importance to the absolute velocity than to the duration of flight.

It should be recalled, however, that these two qualities are not fundamental. The absolute velocity itself depends on the wind and the individual velocity, and from our point of view it is only important if it is attained by the caprice of the wind but in the direction desired by the pilot. To accomplish this, there must be individual velocity, a fundamental property.

The duration of flight is itself dependent on the carrying capacity. We must, therefore, conclude that of these two fundamental properties it is the individual velocity that stands first and the capacity of transport takes second place.

As stated in the beginning of this discussion, I have arrived at these conclusions simply from utilitarian considerations. If we examine the question from the point of view of the difficulties to be overcome, what rank shall we assign to these two essential qualities of an air-ship? For an aeroplane the question is very simple; the difficulties are the same in acquiring one as in acquiring the other. With an increase in the individual velocity, the possible load per square meter of sustaining surface is increased. Consequently, in making an advance in one a gain is made in the other. The question can be summed up by saying that an aeroplane should be as perfect as possible; that is, it should be stable, have carrying surfaces endowed with the best sustaining qualities, a good propeller, and a powerful and light motor. If it possesses such perfection it can be used in any way desired; it can travel swiftly and yet carry a considerable weight that may be utilized either as useful load or to increase the duration of the flight. If its load is lightened its speed will be diminished, but its abundant motive power will enable it to ascend. To conclude, with a perfect aeroplane the aviator may obtain whichever quality he desires or combine them in whatever proportion he deems convenient.

In the case of aeroplanes, therefore, we may say that the question of difficulties to be overcome is

negligible, and that utilitarian considerations alone determine their value. In these machines it is the individual velocity, as it is in all other types, which is the most important quality, but the others can be obtained without modifying the construction in the slightest degree, and except attaining altitude, without losing any velocity, but even gaining it, with an increase in the carrying capacity and in the qualities which are dependent on it.

This is not the case with dirigibles. To be sure, with them as with aeroplanes, general perfection of apparatus—motor, propellers, forms of small resistance—is indispensable to velocity and can likewise exert a favorable influence on the carrying capacity and its resulting consequences, but another factor intervenes, the volume of the balloon. This exerts an enormous influence on the carrying capacity, which dwarfs that resulting from the general perfection of the apparatus. Although by increasing the individual velocity we can indirectly increase in a slight degree the carrying capacity, we possess, moreover, a means of increasing this quality absolutely independent of those which produce velocity. I may add that this method has no great merit in its application. It is not very difficult to add a few hundred cubic meters to a balloon, or even more. I would not go as far as to say that the problem is of extreme simplicity, but it is a small matter beside those that have to be solved in increasing the individual velocity of a dirigible. Consequently, as far as machines lighter than air are concerned, if from a utilitarian point of view the carrying capacity is an inferior quality, it is equally so from a technical standpoint, for it is much easier to attain than individual velocity.

Thus there are in an air-ship only two fundamental qualities from which all the others are derived, individual velocity and carrying capacity; and from a practical standpoint the latter is much less important than the former.

In considering the difficulties to be overcome, in an aeroplane the question does not arise, for in such apparatus the qualities sought for are so involved one with the other that every added improvement allows of the increase according to choice of one or the other of the properties desired in an air-ship. With dirigibles this is not the case, for carrying capacity is much more easily obtained than individual velocity, and the technical considerations which are involved in machines lighter than air are merely those that are basic in the utilization of an air-ship.

Simply because a colossal dirigible has accomplished long journeys and covered great distances, the superiority of this type of air-ship over all others should not necessarily be proclaimed. The machine that should interest us most is the one capable of the greatest individual velocity, and as this velocity is difficult to measure, we should estimate it from the absolute velocity attained in flying in a closed circuit in such a way as to eliminate from the final result, as much as possible, the effect of the wind.

I believe that in this respect our air-ships have nothing to envy in those of foreigners. I even believe frankly that ours are superior.

We can continue to be proud, then, of our air-ships; they possess to a higher degree than others the first of all qualities, individual velocity. They are gaining in this respect from day to day, and when our engineers desire it they can provide them besides with the carrying capacity of which our rivals are so proud.

France is in no danger, as has been frequently loudly announced, of losing the empire of the air.

<sup>2</sup>These lines were written before the catastrophe of the dirigible "République." This tragic event, nevertheless, does not alter the conclusions of this article in the slightest degree.—Renard.

#### The Stresses in Screw Threads

In the last report of the British Engine, Boiler and Electric Insurance Company reference is made to the stresses in threaded bolts, and a graphical presentation of the subject is made, which clearly shows the effect of the difference in lead in bolt and nut upon the stresses in the thread. The difference in lead between the thread on the bolt and in the nut is one that is difficult to overcome. In fact, very few nuts have the same pitch as the bolts they are supposed to fit. The pressure between the threads of the nut and the bolt is therefore, generally, not the same on every thread. If the lead of the thread of the screw is longer than the lead of the nut, the stress will be concentrated on the lowest thread, but if the lead of the thread in the nut is longer than the lead of the bolt, the stress is greatest on the top thread. If the lead of the screw and in the nut be exactly equal, the stresses will be equally distributed. The cut shows in a clear manner the way in which the stresses are distributed in the three cases. It is evident that the risk of stripping the threads is far greater in cases where the lead of screw and nut differ, as there the stresses will be concentrated on

one thread, and the threads are stripped or sheared off one by one. The danger of breaking the bolt is also greater in that case, because, if the threads are strong enough to withstand stripping, then the whole force of tightening the nut will be applied on one

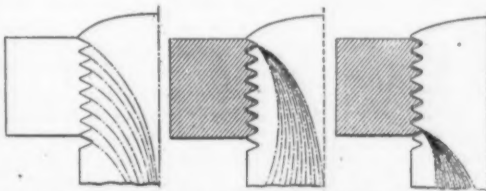


DIAGRAM IN STRESSES IN SCREW THREADS.

thread, in the bottom of which a fracture is then the more easily started.—Machinery.

#### Phosphorescence of Diamonds

MANY diamonds which have been exposed to sunshine give out light when placed in a dark room. When placed in a vacuum and exposed to a high-tension cur-

rent of electricity, diamonds phosphoresce, or shine with different colors. Most South African diamonds, under these circumstances, exhibit a bluish light, while diamonds from other parts of the world shine with such colors as bright blue, apricot, pale blue, red, yellowish green, orange and pale green.

One beautiful green diamond in the collection of Crookes, when phosphorescing in a good vacuum, gave almost as much light as a candle; the light was pale green, almost white.

#### Working 150 Days Without Stopping

Nor so long ago, in a gas factory at Ivry, near Paris, a Laval turbine, driven by jets of steam, was set to work, and once fairly under way, was driven for 3,600 hours, or 150 days, without stopping for an instant. An automatic oiler kept it lubricated, and a workman visited it once in twelve hours to replenish the oil reservoir. The speed of the circumference of the rotating disk being about six miles per minute, a point on that circumference must have traveled in the course of the 150 days almost five and one-half times the distance from the earth to the moon.

# Johann Wolfgang von Goethe

## His Relation to Science and the Useful Arts

The great German poet Goethe is so pre-eminently famous for his literary and dramatic creations, that his contributions to science and industry, which were of no mean order, have received much less attention than they deserve. The subject has recently been discussed by various German authors, among them Geitel, who made it the topic of an address before the Society of German Marine Engineers.

Among the productions of Goethe's scientific genius may be mentioned his work on plant-metamorphosis; his discovery of the intermaxillary bone in man and in the ape, whereby the similarity of the skeleton of the two species was confirmed; his vertebral theory of the skull; his dissertation on geology and meteorology and his rather ill-fated theory of color.

Goethe's long life fell into a period of remarkable scientific and industrial awakening (1749 to 1832) and a mind of the magnitude and breadth of his could not fail to be deeply impressed by the great developments

wright's mechanical loom, of coal gas by Murdock, these are some of the remarkable events which characterize this great epoch.

Goethe's interest in science and technical arts was not merely of the passive kind. Of his scientific work mention has already been made. Something of the nature of prophetic insight is shown in the view expressed by Goethe of electricity in his "Versuch einer Witterungslehre," where we read:

"It (electricity) may be said to be in the highest degree problematical. We must therefore regard it as essentially independent of all other phenomena; it is the all-permeating, ever present element which accompanies all material and atmospheric existence; we may in fact think of it as the 'Soul of the Universe.'" Reading these words in the light of modern science, we are impressed with the strange accord in which they stand with our most advanced conclusions.

Rather less fortunate was Goethe in his efforts to

In this way he superintended the measures of relief and reconstruction after a heavy flood of the river Saale at Jena.

His work in connection with agricultural improvements also was eminently successful. The position which the industrial life of the nation occupied in Goethe's mind cannot be better expressed than in the words which he himself has put into the mouth of his greatest dramatic character, Faust. It will be remembered how this hero of romance, after seeking in vain satisfaction from various earthly pleasures, at last derives supreme happiness from the contemplation of a busy throng of toilers, a people raised to well-being and prosperity by his own endeavors and his skillful command of nature. Says the dying Faust:

"And such a throng I fain would see  
Stand on free soil among a people free,  
Then dared I hail the moment of flying,  
'Ah, still delay—thou art so fair!'  
The traces can not, of mine earthly being  
In aeons perish—they are there!  
In proud fore—feeling of such lofty bliss  
I now enjoy the highest moment—this!"

### The Effects of Radium Upon Living Cells

From a number of studies on the effects of radium upon plant and animal growth made by different investigators, Dr. William Allen Pusey of the University of Illinois has made a summary which he presented before the Illinois Academy of Science.

In plants as well as in animals the action of radium rays and of radium emanations is quite similar to that of the X-rays, which had been studied more thoroughly, whatever differences there are being apparently only of degree. All the effects can be compared to actinic effects of different kinds of light rays, and are to be considered as influencing the processes within the cells rather than as producing a specific chemical reaction. The distinctive effect of the action of radium may not appear until several days or two weeks after the action has been suspended.

In plants the first effect is a stimulation of growth; after longer action, or with stronger application growth is retarded or even entirely stopped. On animal tissues radium acts most decidedly upon cells in which functional activities are greatest; thus, embryonic or growing cells are stimulated to more rapid growth, while pigment cells of the skin produce more pigment and connective-tissue cells are the last to be affected. By using preparations of lower intensity the action of the radium may be restricted to diseased or weakened portions of the skin. It is thus possible to use the rays for destroying tuberculous nodules or cancers in the skin.

A description of the successive stages in the changing appearance of the skin under the action of radium is a picture of a severe case of "sun-burn." There is at first a tanning, followed by reddening of the skin, accompanied by the feeling of burning; and later there is a scaling of the skin. If the action is continued there appears a stage that is known only as a result of X-rays or of radium: the skin becomes congested and blisters are formed; the hairs fall out; later an ulcer may form after the bursting of the blisters. This ulcer is very painful and very slow in healing, remaining sometimes for months. There are permanent changes in the skin, whether the ulcer is produced or not. The hair rarely grows again, many of the sweat glands are destroyed, and the skin remains red from the dilation of the capillaries; numerous rough, horny patches are formed. Some of the phenomena are similar to senile changes in the skin, and the suggestion has accordingly been made that the latter are the result of the continuous action of actinic rays of sunlight for many years.

From the special types of results produced there are drawn suggestions for therapeutic applications:

1. The stimulating action upon growth, in low intensities, may be applied to hasten various healing processes in the skin.
2. The destructive action upon the hair follicles has been applied in the case of X-rays; on account of the small quantities of radium available this has been used for destroying hairs only on hairy birth-marks.
3. The obliteration of blood-vessels in the skin (through the proliferation of lining-cells induced by the radium) has been attained in the treatment of vascular birth-marks (such as "strawberry-marks").
4. The destructive action upon pathological tissues has been used successfully in certain skin diseases, especially in certain types of skin cancers.

The action of radium rays upon bacteria and protozoa has been investigated for several species and the general effects are similar to those upon the growth of plants, namely, at first a stimulation, followed by an inhibition of activity and eventual destruction.



A RARE ENGRAVING OF GOETHE

that were going on around him. To better appreciate the spirit of the time we will briefly recall a number of notable scientific events that fell within Goethe's lifetime. Among these is the recognition by Franklin of the identity of the lightning flash with the electric spark discharge. Galvani was the first to observe current electricity and Volta discovered the cause of the production of electricity by metallic contact. Then came, in 1806, the discovery of electrolysis by Davy, that of electro-magnetism by Goethe's friend Oersted (1820) and of induction by Faraday in 1831. The electric telegraph Goethe was not destined to know. In the field of chemistry this period saw the overthrow of the phlogistic theory by the epoch-making work of Lavoisier. In the field of the industries the most characteristic feature, which wrought a complete revolution in methods and customs was the transition from hand labor to machine work. The steam engine, perfected to technical success by James Watt, developed during Goethe's life time into that powerful factor in all branches of industry, which it still represents at the present day. The invention of the steamship, the growth of the railway, the first balloon ascent by the brothers Montgolfier, the invention of the Arkwright cotton spinning machine, of Cart-

establish a national theory of color and it is rather to be regretted, that in his controversial writings on this subject he allowed himself to be carried away into utterances of biting and wholly unjustified sarcasm directed against the great Sir Isaac Newton. This drew upon him the displeasure of such men as Tyndall, Helmholtz and du Bois-Raymond; the last mentioned expressed the view that Goethe's methods were "entirely foreign to physics and physical science." As a matter of fact, while the physical portion of Goethe's researches on color phenomena must be regarded as a failure, in so far as his work relates to the physiology of color sensation it has proved not only very excellent but in point of fact of pioneer worth. It is a rather curious fact that Goethe himself, to the end of his life, looked upon his twenty years' labors in the theory of colors as his most valuable production. This failure on the part of certain great men to properly judge the merit of their own productions is not altogether uncommon.

Goethe was actively connected with a number of public works and developments of a technical character, some of which come within his sphere of action in his capacity of councillor of the legation at the court of Karl August, Duke of Sachsen-Weimar.

# Cinematography and Lantern Projection

## The Application of Dussaud's Cold Light to the Moving Picture

By Jacques Boyer

WITH very simple and inexpensive apparatus, M. Dussaud, of Geneva, has succeeded in producing an illumination which is practically free from heating effect and which seems destined to revolutionize the delicate art of projecting moving and other pictures. With this apparatus even an inexperienced operator can easily, cheaply and safely give lantern exhibitions in a school, church or private residence. Cinematography and the projection of photographs in natural colors are also facilitated by this invention.

The projecting lantern is entirely suppressed. For the projection of ordinary black and white pictures two double lenses are mounted in any convenient manner, one before and the other behind the slide (Fig. 1). Behind the second, or condensing lens, is placed the "cold light box," containing a metallic filament lamp operated by a small battery, the current of which is periodically interrupted by a commutator. This intermittent current produces a series of flashes of light which succeed each other so rapidly that the effect produced on the eye is that of an absolutely constant illumination. Yet the interval between successive flashes is long enough to allow the filament to cool and to dissipate the heat generated by the preceding instantaneous current. Hence a higher voltage than usual can be employed without danger of melting the filament. The commutator can be easily and cheaply made by cutting four short equidistant longitudinal grooves in the shaft of a little electric motor, costing a dollar or less, and filling the grooves with some non-conducting material. Two strips of metal are arranged to press respectively on the grooved and the unaltered part of the shaft and the ends of the strips are connected with wires completing the circuit through the battery and the lamp. The motor may be driven by the same or an independent battery.

During a visit to M. Dussaud's laboratory I observed that the glass bulb of the lamp remained quite cold to the touch when the lamp was operated by an intermittent current of 1.5 amperes and 8 volts. Yet the lamp was bright enough to replace the electric arc with advantage and to make a fine projection in colors, more than 6 feet square. The result impressed me the more strongly because we were working in a lighted room with cheap commercial lenses.

Hence this "cold illumination" dispenses with the employment of electric regulators or gas, acetylene, oxy-hydrogen, alcohol or kerosene lamps, which are difficult to manage and often dangerous. The danger of burned films and conflagrations is eliminated, and the lecturer can give free vent to his eloquence without keeping one eye on the man at the lantern.

For the application of the cold light to cinematography M. Dussaud has devised the arrangement shown in Figure 2, which, in addition to other advantages, suppresses the usual fluctuation in brightness and doubles the intensity of illumination. In the first place, the negative film is passed successively through

arranged on the shaft of the crank and fly wheel, each lamp is lighted only while the film in front of it is motionless. Hence the screen is illuminated continuously, and not intermittently, as it is in the customary method. The result is that the eye observes no fluctuation, and receives twice the usual amount of light. The two half films cost no more than a

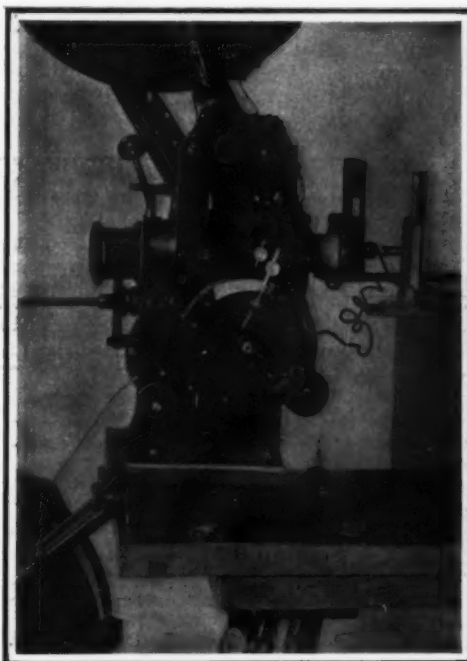


FIG. 1. DUSSAUD'S APPARATUS FOR PROJECTING MOVING PICTURES

single whole film and, although the illumination is practically doubled the expense for light is no greater than in the usual arrangement, where half of the light is wasted by the interposition of a shutter. The elimination of the shutter and its mechanism compensates the additional cost introduced by the two sets of reels and the flexible cordan connection, which is required to make the two series of pictures coincide.

M. Dussaud's invention also greatly simplifies the operations of photography in natural colors. Three negatives are made on films of proper sensitiveness, with an ordinary camera, in front of which three colored glasses, green, violet and orange, are successively placed. These three negatives are copied on a single strip of film which, when placed in the triple

thus superimposed on the screen, form a single picture in natural colors. The coincidence of the three images on the screen is secured, once for all, by the construction of the apparatus and the correct printing of the three pictures on a single film.

M. Dussaud's cold light will also prove valuable in the microscopic examination of delicate objects and in many other cases in which intense illumination is required but heating would be injurious.

### The Ants of Herodotus

ONE of the earliest, if not the first, of Tibetan romances dates from the days of Herodotus, nearly five hundred years before the Christian era. The "Father of History" gives a cautious admission of probability, but by no means a cordial assent to this "traveler's tale," which later travelers have repeated and explained.

It was said that in the extreme northwest of India there existed a race of enormous ants, fierce and powerful, whose peculiar mission in life was the digging out of gold. Traders, mounted on swift camels, occasionally seized the gold which was accumulated in heaps by these excavating ants. When they succeeded in doing this, they rode rapidly away, pursued by other ferocious guardians of the soil, in the form of fierce wild beasts, which slew them if they caught them.

Among all the ludicrous exaggerations of ancient classical tradition relating to India, this story evinces a remarkable tenacity of existence. It is repeated in every tale of the East that was told by compilers and adventurers before the days of Herodotus, and is only doubtfully classed by him as fiction. It was not until, in recent years, the trans-Himalayan explorers of the India Survey recorded their experiences that any light could be thrown on the origin of it.

These explorers, making their way painfully over the terrific altitudes which intervene between India and western Tibet reached at length the gold-mining districts which lie beyond the mountains on the great western plains. Here they discovered the Tibetan workman delving for gold after a fashion of his own.

The intense cold and the fierce winds of the highlands compelled him to grovel on the ground enfolded in a thick black blanket, while he dug, or scratched, painfully and slowly, with the end of the first tool available to his hand, which was usually the horn of the Tibetan deer. To all appearance he was a rough imitation of a huge-horned ant, grubbing up the auriferous soil, and piling it in heaps for subsequent washing.

Guarded by immensely powerful dogs whose ferocity is well-known among travelers in Tibet, he has pursued his calling from those very early days until now, hardly improving his processes, making but slight impression and shallow indentations in the

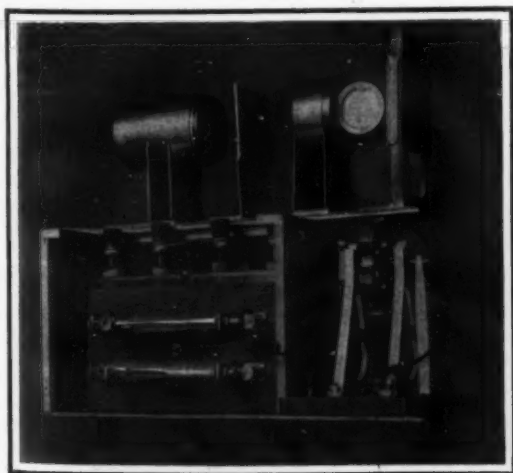


FIG. 2. DUSSAUD'S APPARATUS FOR PROJECTING PICTURES WITH "COLD LIGHT"

two printing machines, which reproduce the odd-numbered pictures on one positive film, and the even-numbered pictures on another. The projecting apparatus is double, comprising two lamps and two sets of lenses, and the two positive films are introduced in such a manner that, when the crank is turned, each film moves forward while the other is at rest and is being projected. By means of commutators suitably

projecting apparatus shown in Figure 3, produces on the screen a single picture in natural colors. The projecting apparatus comprises three "cold light boxes," three condensers, three objectives and three transparent screens, the colors of which, red, yellow and blue, are complementary to those of the screens which were used in the camera. By the law of complementary colors, the three colored pictures which are

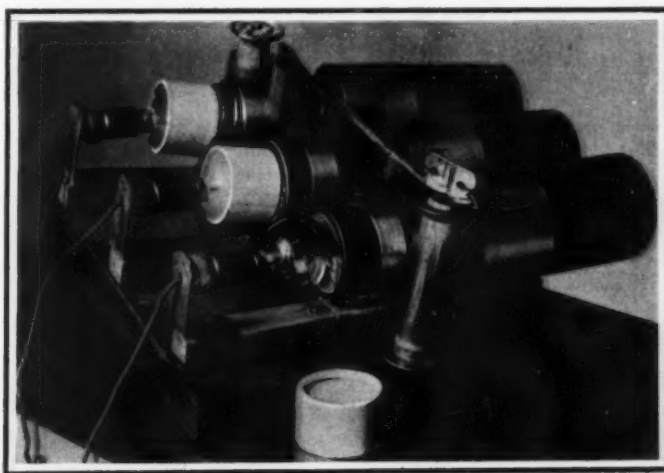


FIG. 3. DUSSAUD'S APPARATUS FOR PROJECTING PHOTOGRAPHS IN NATURAL COLORS

soil, and probably leaving behind two-thirds of the gold which it contains.

This is the solution of the early romance.

Colored Strass for Topaz (according to Donault).—(a) Colorless strass 1,000 parts, antimony 40 parts, cassius purple 1 part. (b) Colorless strass 1,000 parts, oxide of iron 10 parts.

# Aeroplanes in Naval Warfare\*

## A Consideration of Their Possibilities

By a German Naval Officer

### A—DEVELOPMENT.

THE development of the aeroplane is more recent than that of the dirigible, and it has been more rapid. The following is a brief review of its progress:

The first successful flights with motor-driven aeroplanes (aside from the later abandoned tests of the Frenchman Odet, during the nineties of the last century) were made in Europe in the fall of 1906 by the Dane Eliehammer and by Santos Dumont, although the Wright brothers in America had achieved remarkable success even before this. As the American inventors did not, however, make their attempts public, but did so only when they saw the danger of being outstripped by French aviators, we may take as the beginning of the present period of development the fall of 1906. It took an entire year before H. Farman (January 3rd, 1908) made a successful round trip of 1,500 meters at a height of a few meters, winning the Deutsch prize of 40,000 francs. At the end of that year, the greatest distance covered was 124.7 kilometers; at the end of 1909, this was 234 kilometers, and in the end of 1910 it was 583 kilometers. The longest continuous flight was made a short time ago by H. Farman, remaining 8 hours, 12 minutes, 54 seconds in the air without a descent. The greatest altitude reached in the end of 1910 was 3,474 meters, the greatest speed, 140 kilometers an hour, and the greatest number of passengers taken up by an aeroplane was six. We must admit that these are remarkable strides within the last three years.

### Dangers in Flights.

In spite of all this we are still far away from the conquest of the air with aeroplanes, for their safety in flight and operation is far behind that of dirigible balloons. The efficiency and safety of the aeroplanes is dependent on the perfect working of the motor, even more than is the case with the dirigible balloon. If the motor fails, an unintentional limit is set to flight, and, more than that, have in many cases resulted in dangerous situations for the aviator, who must descend in a gliding downward flight. He has very little influence on the choice of a landing place, and, under circumstances, cannot avoid a catastrophe, especially if the motor stops at a low height. Causes of accidents due to breaking and falling of constructive parts of the aeroplane, can be avoided more and more in the future, for we have gradually learned to judge the needed resistance of all parts properly. The carrying capacity of the aeroplanes is also great enough to a low excessive economy in weight to seem unjustifiable. In the past, of course, frequent accidents have happened due to the constructive material failing; most of these accidents being started by snapping of stiffening rods and wires. Monoplanes have suffered especially by breaking of the wings; but breaking of screws, breaking of chains and mishaps on the steering gear have also occurred.

Aside from the defects in the aeroplanes themselves, whose gradual elimination is to be expected, there are two further important causes of danger. The one is the element which we would like to rule, the other is in the aviator.

The dangers of the air are gusts of wind, whirlwinds, and, above all, vertical movements of the air. These phenomena lead to danger, not only on, or near the surface of the ground, but they destroy the stability also in flight at greater altitudes and may be causes of falls. The art of the aviator can meet these dangers to a great extent; this art can be attained only through long practice and intimate knowledge of the element just as the sailor learns his art thoroughly only through continuous battle with his element.

The dangers, finally, which rest with the aviator, are, that he makes blunders, that he dares too much, or underestimates the dangers of the weather conditions. These dangers also can be met by proper education and teaching.

The burning questions are, therefore, perfection of motors and education of a good corps of aviators. It is just as certain that even after reaching this goal, we will have accidents, as it is a fact that we cannot avoid them in other callings. They must be accepted, just as we have to accept the accidents on sea and in mines.

### State of Development.

When we turn to the present state of aeronautics, we find that the efficiency is shown by the records mentioned above. The records have a special significance in the realm of aeronautics, because in the sharp competition of systems and types of construc-

tors and aviators, as also of nations, every record reached is soon broken. In this way a wonderful result becomes soon a common one and the average efficiency increases. We must thank the sharp competition in all lines for the rapid development of aeroplanes.

France at the present date holds all records, except that of height, which has been contested within the last few months by America, and the former has about 87, or 70 per cent of the total number of highest performances. America follows with 37 records; about 30 per cent. The American successes are, however, of a slightly more distant date, so that the superiority of France within the last year is even more remarkable than is evident from the figures.

### Use of Mono and Biplanes.

Another question is also answered by the records, taken as indicators of efficiency; namely, how to value the two systems, the monoplanes and biplanes, which are at present competing against each other.

While up to the middle of 1909 the biplane was the head in all lines (distance, endurance, height, speed and passenger flights) it has since that time shown itself inferior to the monoplane. As regards speed and distance, the monoplane is absolutely superior. On the other hand the biplane has an important line, in which it has remained victorious, namely that of passenger flights. Against the six persons that the biplane can carry, the monoplane has, up to now, only carried three persons.\* Since probably in the future there will be no change in the relation between the two types, we have in these characteristics the right of existence for both types of aeroplanes: the biplane as load bearing, the monoplane as speedy aeroplane. Both will be used according to demand.

Aside from these main differences, we attribute greater stability in flight to the biplane, and prefer it because descent and landing are less dangerous than in the monoplane, due to the lower speed. Finally aviator and passengers are easier to accommodate and have a better outlook, both front and below, mostly unimpeded by the air current of the propeller, which is often very disagreeable in monoplanes. These factors speak favorably for its use in reconnoitering.

It must be said in favor of the monoplane that it uses less space and can be assembled quickly for use and again quickly dismantled for transportation. This point is important for its use on shipboard.

Although, besides these kites a large number of other aeroplanes have been constructed and tested, no great results have been achieved with such aeroplanes, so that it does not pay, at the present, to draw them into our discussion.

### The Motor.

I would like to enter briefly on the motor question. How to cool the motor for aeroplanes is a very important question.

The first French aeroplanes were mostly equipped with air cooled motors. This cooling permits the construction of a very light motor, as cylinder jacket, radiator, water pump, and pipe lines are eliminated; it has, however, proved insufficient in its elementary execution, so that the motors, due to extensive heating of cylinders during flight, lose in efficiency and are not fit for endurance tests.

The Wrights, and many German firms, on the other hand, use water cooled motors, which are of course heavier, as already stated, but give more uniform results. Lately, however, the problem seems to have been solved in favor of the lighter air cooling system, by the introduction of rotating motors. In these the cylinder casing rotates at about 1,200 revolutions per minute around the stationary shaft, whereby the external cylinder parts, that are to be cooled, move with great speed (about 50 meters) and consequently experience efficient cooling by the air through which they speed.

At the same time the rotating mass serves as an effective flywheel whereby a very uniform operation is caused.

The most numerous records have been obtained within the last year by the French Gnome motor, the first and most successful of this type. Germany began recently to build these rotating motors, but they still have to prove their efficiency in the competitive battle.

The weight of rotating motors with safe operating

\* These records are now obsolete. The Blériot "aérobus" has carried as many as twelve passengers and the pilot; the Breguet biplane has carried 11 passengers and the pilot.—Ed. Sci. Am. Sup.

conditions is given as 1.0 to 1.5 kilogram per horse-power, whereas water cooled motors weigh hardly less than 2.5 to 3 kilograms per horse-power.

### B—USE IN NAVAL WARFARE.

#### Reconnoitering—Use in Coastwise Signaling.

It is evident that reconnoitering will be the main sphere of action for aeroplanes. Just like the dirigible it will be possible in certain cases for the aeroplane to supplement the signal and information service on land with more or less reliability.

If we take as efficiency a time of flight of four hours and a speed of 80 km. hr., it is possible for an aviator sent out from the coast observation station to reconnoiter large regions of the Baltic Sea. France has also tried successfully to equip the aeroplanes with wireless telegraph outfits. But this can mean instruments for short distances only; and in the future, we will probably not be able to count on any far-reaching wireless equipment on account of the weight. The resulting information will therefore be known only after the return of the aeroplane, as is not the case with airships. When we consider the great speed with which the aeroplane travels, such reports will still be very valuable. As a distinct advantage of the aeroplane we must consider the fact that it can approach the enemy within a comparatively slight distance in order to take observations, since the aeroplane offers a very small target, so that it need not fear hostile shells.

As regards spotting of submarines and mines, the same holds true here as with the airship, with the addition that an accurate determination of locality is even more difficult for the aviator in the aeroplane than in the airship.

#### Use for Reconnoitering in Connection With a Fleet.

On the other hand the work of reconnoitering in the service of the navy is reserved to the aeroplane. An example will illustrate the importance of such a service. An enemy blockading the mouth of the Elbe River wishes to know where German ships are anchored, in order to move light bodies of troops at night. An aeroplane sent out just before darkness will give good service. Again, the reconnoitering ships of both sides meet in battle. Authoritative information seems out of question, although information as to the strength of the hostile force is essential. Again an aeroplane will be useful. So far the transmission of orders and reports, the aeroplane can be employed with great usefulness, from shipboard to land and from one ship to another, as, for example, in connection with separate squadrons of a fleet; and finally for communication between land and shipboard.

In this use we have the further question of possibility of flight and landing on board ship. With a good road and start into the wind the aeroplane can rise with an initial start of 30 to 40 meters on an inclined plane, perhaps even faster. At any rate it will be possible to find a deck of sufficient length on large ships, which can be equipped for a satisfactory start. At the end of 1910 an aeroplane rose from the rear promenade deck of the German Hamburg American Line steamer "Kaiserin Auguste Viktoria" near Sandy Hook and carried dispatches and mail to land. In New York Harbor similar starts from Hamburg American Line ships were tried with success. It would be more difficult to find room for such a starting platform on warships where the disposition of the guns is of first consideration. It would be possible, perhaps, to use starting devices similar to those used originally by Wright machines; probably on board with sufficient height for the starting flight a shorter distance will be sufficient than is customary on land since the aeroplane, as soon as its wheels have left the deck, begins a gliding flight, which the influence of the propeller with increasing horizontal speed will change into the normal soaring flight.

The possibility of such a start from a warship was illustrated by the successful trial of the American aviator Ely, who toward the end of 1910 flew to land from the American protected cruiser "Birmingham." More difficult than this problem will be alighting on such a limited space as is available on board ship. But this problem also was solved in January, 1911, by Ely, although such special arrangements had to be made on the American cruiser "Pennsylvania," as would be impossible in actual warfare; on the rear deck was an inclined wooden track of 40 meters length and 18 meters wide and a receiving device for the aeroplane. But this could be avoided by having the aeroplane descend on the water and then raise it up on board as one would raise a boat. For this purpose either the frame or the planes must be made

\*Marine Rundschau.

to float or special floating runners must be used, which, however, would have the disadvantage of causing a special air resistance. Whatever it may be, aeronautics has already surpassed greater obstacles than these. It is very likely that a competent solution will soon be found. For only with this point in view is it possible for the French to have made steps to introduce aeroplanes in the navy, and they intend to equip land stations and special ships in this way. An old cruiser "Foudre" is being rebuilt for this purpose. It is no wonder that they made the start, in view of the advance standing which they enjoy in the realm of flying. The Americans will probably follow in the near future, for several years ago, the War Department announced a high prize for an aeroplane which can start from shipboard and can alight on the water. A Curtiss aeroplane has fulfilled the most essential requirements in January,

1911, in San Francisco, by rising from the water and alighting on the water. This aeroplane had cigar-shaped floating runners. All this shows with what zeal America tries to make the aeroplane useful for naval warfare. Since the German budget has also means for tests with aeroplanes, it is to be hoped that this will be a further spur for all interested parties, to bridge over the gap, which separates Germany in this line from the other two nations.

#### Other Possible Uses.

As a last point we must view offensive possibilities of aeroplanes. We should consider that an aeroplane to be used above the sea, should have a great safety factor of operation and great duration of service, so that it may again reach its home destination in safety. Great safety for operation requires great weight, endurance in operation demands a large supply of benzine and gasoline. Moreover, a second person

should ride along as observer and for the navigation, compass and navigating instruments will be necessary. There is little space left for conveying any means of attack, save with a few light hand grenades, or similar explosive projectiles, which at times may be effective against torpedo boats, submarines or dirigible balloons. But on the whole the aeroplanes will always lack any noticeable offensive power for naval warfare. In addition to this we have the difficulty in hitting a target when throwing missiles during the rapid flight.

The aeroplanes are and will be useful mostly for reconnoitering.

We do not intend to assert that aeroplanes are at the present time adapted to all the uses mentioned, but that the present state of development gives hopes that these will be reached within a short time. Then it will be time to test them in practice.

## An Apparatus for Recording Loss in Weight

Kuhlmann's Photographic Method

By the Berlin Correspondent of the Scientific American

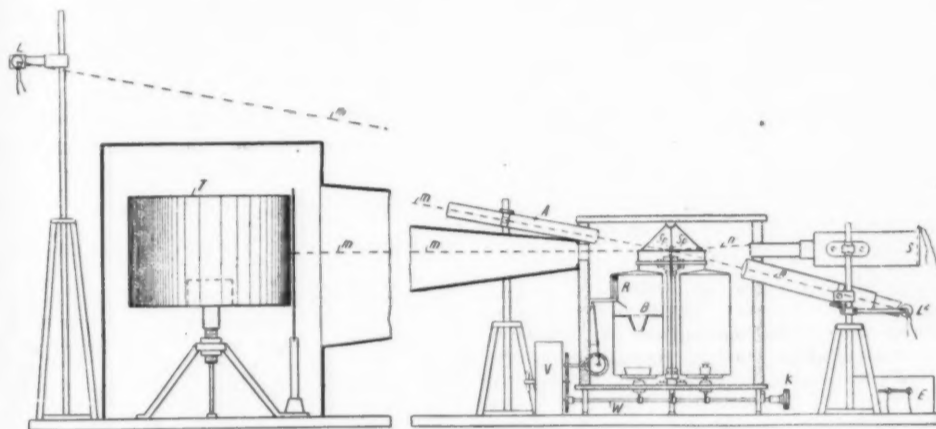
A TASK with which we are frequently confronted in laboratory work is that of observing and recording with accuracy the loss in weight suffered by some substance under examination. On account of the unavoidable friction of the tracing point, the mechanical

revolving drum *T* is provided with photographic paper.

The operation of automatically actuating the arresting shaft *W* is effected as follows: On the shaft are mounted three arresting eccentrics and also an

weighed is placed upon the left-hand pan, and the scale is adjusted by means of weights and riders until the beam of light *m* just strikes the lower edge of the photographic paper. The drum is then started in its rotation and the apparatus is left to its own devices.

While the description here given was applied specifically to the case of a substance losing weight, obviously the same apparatus can also be used to keep track of the gain in weight of a hygroscopic material



DIAGRAMMATIC SECTIONAL VIEW OF KUHLMANN'S REGISTERING BALANCE

recording process commonly employed for various other instruments, such as registering thermometers and barometers, proves utterly inadequate for use in connection with a balance.

To overcome this difficulty, Mr. W. H. F. Kuhlmann, of Hamburg, has designed a new method by which it is possible to record photographically to within one milligram any loss in weight undergone in a space of five or six days by three to four grams of material. It lies in the nature of such a photographic recording device that there is no friction, and hence a highly sensitive chemical balance can be used. The arrangement is diagrammatically represented in our accompanying illustration. The balance employed is one of about 200 grams capacity. The beam carries at the back in the extension of the central knife edge two plane mirrors *Sp*, *Sp*, pointing to right and left respectively. About two meters from the left-hand mirror a two-volt Osram lamp *L* is mounted upon a support in such manner as to allow it to be set in any desired position. The filament of this Osram lamp is projected by means of a lens contained in the tube *A*, on the mirror *Sp*, and thence on the recording drum *T*, coated with photographic paper. As the mirror swings with oscillations of the beam, the image of the filament is seen to move up and down upon the drum *T*. The sensibility of the balance is so adjusted that a vertical motion of two millimeters corresponds to a loss of one milligram in the substance weighed. As the drum *T* is rotated by clockwork around its axis at a known speed (7.25 millimeters per hour at the circumference) a curve is thus obtained which indicates graphically the rate of change of weight with time.

The height of the drum (and the width of the photographic paper) is 200 millimeters. As soon as the deflection of the beam of light has reached this limit, or, in other words, as soon as 100 milligrams of the substance have vaporized, the scale pans are arrested automatically by a clock-work *V*, and a weight of 100 milligrams is dropped into the cup *B* above the vessel containing the substance. This brings the spot of light back to the lower edge of the revolving drum, and the record of the rate of loss in weight can be continued. This cycle of operations can be repeated over and over as long as desired, and as long as the

escapement actuated by an electro-magnet at the instant when the beam of light *m* attains its highest position on the drum. The 4-volt Osram lamp *L2* then throws a beam of light on the selenium cell *S* enclosed in a box. It is well known that the electric conductivity of selenium is increased under the action of light. In consequence of this, when the spot of light strikes the selenium cell *S*, the relay *E* communicating with *S* is actuated, thus closing the circuit of an electro-magnet, which in its turn, disengages the escapement of the arresting shaft *W*, while actuating the clock-work *V*. The one decigram weights are made in the form of aluminium disks packed one over the other in a slotted tube *R*. A slide, actuated through toothed wheels by the clock-work *V*, withdraws one weight each time the balance is arrested, and drops it into the cup *B*.

The operation of the apparatus is as follows:

After placing a roll of photographic paper upon the drum *T*, the receptacle containing the substance to be

#### A New Internal Combustion Turbine

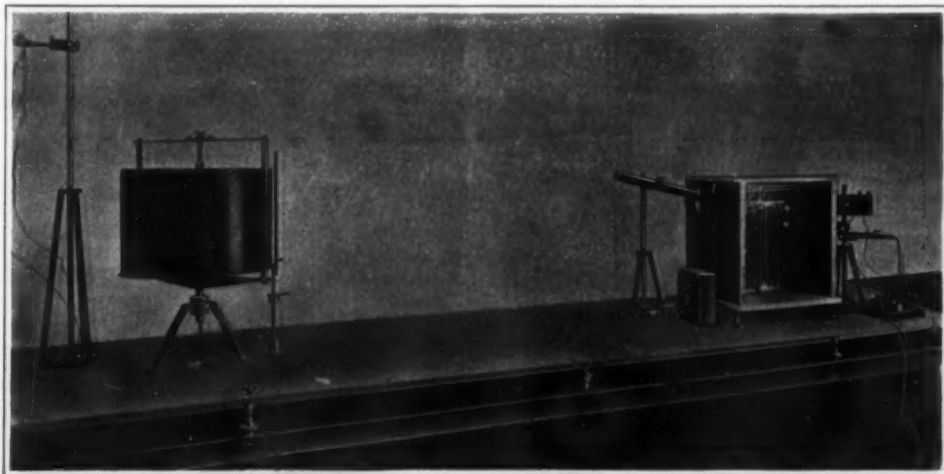
A ZÜRICH machine company has constructed an internal combustion turbine according to the plans of Max Imhoff, a Swiss engineer. Many inventors have been working on the question of building a turbine resembling a steam turbine which acts on the explosion principle, but with little success. The new Swiss turbine is said to run very well upon gasoline or other usual kinds of liquid combustible, and is light and of small size for a given power, the present one weighing but 155 pounds for 120 horse-power. It is to be used in the first place on a torpedo boat.

#### England and the Metric System

DURING the last meeting of the International Committee of Weights and Measures at Paris, it was announced that the Australian parliament desired to see England adhere to the metric system, on the example of Canada and New Zealand. In this connection we may state that according to the Paris journals it appears that there was a tacit understanding between France and England that if the former adopted the standard Greenwich time, as it has now done, the latter would reciprocate by adopting the metric system.

#### A Successful Submarine Night Attack

THE French submarine "Monge" was able to make an attack by night during the recent maneuvers, which shows that it can no longer be maintained that submarines can see their way with the periscope only during the day and become useless at night. In the maneuvers, the "Monge," commanded by Lieut. Masse, was able to run during the night of the 9th and 10th of May and succeeded in sending a torpedo against the admiral's ship "Leon Gambetta." This is the first time that the feat has been accomplished in Europe.



GENERAL VIEW OF KUHLMANN'S REGISTERING BALANCE

## Automobile Novelties

### A Tipping Van; An Automobile Tractor; An Armored Steel Bank Car

#### A TIPPING VAN.

The tipping van constructed by Messrs. De Dion-Bouton is mainly destined for the transport of refuse and other waste material. As the traveling speed accordingly is a matter of secondary importance, this vehicle is only fitted with a one-cylinder nine horse-power motor which greatly simplifies the arrangements, while reducing the fuel consumption to a minimum. The cylinder bore is 100 millimeters (3.97 inches) the stroke 130 millimeters (5.12 inches), and the motor



A TIPPING VAN FOR TRANSPORTING WASTE MATERIAL

speed 1,300-1,400 revolutions per minute.

The thermal efficiency is said to be excellent; the ignition is of the high-tension magneto type. A Cardan gear in conjunction with a friction disk clutch serves for power transmission from the motor to the driving shaft. The change gear allows of a backward and three forward speeds, the maximum speed being 25 kilometers (15.53 miles) per hour. The tipping device is operated in either direction by means of a handle and a steel cable.

The effective load transported by the vehicle is 1,000-1,200 kilograms (2,204.6 to 2,645.5 pounds).

#### A NOVEL AUTOMOBILE TRACTOR.

The tractor recently invented by M. Van der Voort, of Brussels, shows the advantage of having four driving wheels to which the weight of adhesion is evenly distributed. Its range, with a single charge of gasoline, can be increased to 1,000 kilometers (621.4 miles); its weight is remarkably small and the risk of slipping is reduced by the use of the number of driving wheels above mentioned.

This tractor is 3.70 meters (12.14 feet) in length and two meters (6.56 feet) in width, the wheel base being 2.50 meters (8.2 feet), thus giving an area of 7.4 square meters (78.95 square feet). The substantial and simple carosserie generally comprises a roof above the driver's seat, beside which another person, e.g., the operator of the brake of the trailer, can be accommodated.

The four-cylinder gasoline motor is 114 millimeters (4.49 inches) in bore and 150 millimeters (5.91 inches) in stroke. With a speed of 400 revolutions per minute it yields 25 horse-power, with 720 revolutions per minute 36, with 800 revolutions per minute 40, and with 1,000 revolutions per minute 50 horse-power. Only 400 revolutions per minute, viz., a force of 25 horse-power, is required for transporting a total load of 15 tons at 10.8 kilometers (6.71 miles) per hour, corresponding to an efficiency of 75 per cent. With a satisfactory regulation of the carburetor, the gasoline consumption works out at 0.3 kilogramme (0.66 pounds) per horse-power-hour. After slightly modifying the carburetor, benzol can be used as fuel.

The four driving wheels are fitted with rims having elastic inserts according to the Van der Voort patents, being one meter (3.28 feet) in diameter and 1.54 meters (5.05 feet) in gage.

On snow-covered roads the steel plates of these rims should be replaced by blocks of very hard wood, insuring a perfectly smooth running. In the case of average speeds of only 6-8 kilometers (3.71-4.97 miles), ordinary wheels with steel flanges can be used as well, whereas with speeds intermediary between 15 and 20 kilometers (9.32 and 12.4 miles) (e. g., for conveying fire pumps postal vans, etc.) massive rubber rims are preferable.

The steering is effected by a long worm, meshing with the gear. As the ends of the axles are spherical, being fitted with universal clutches, the steering lever about 15 centimeters (5.91 inches) in length, to which are transmitted any vibrations of the wheel, can be dispensed with, though it is otherwise necessary.

By adjusting the wheel to an angle of 45 degrees, a curve of six meters (19.68 feet) radius can be tra-

versed in turning round. When using a suitable triangular clutch, the trailer can be adjusted to exactly the same curve. In order to negotiate even sharper curves, instead of two, all four wheels should be made steerable, the rear wheels being actuated by a transversal cardan instead of by chains.

The motor generally comprises a regulator for so controlling the gas admission that the speed of rotation corresponding to a traveling speed of 10 to 12 kilometers (6.21 to 7.35 miles) per hour cannot be exceeded.

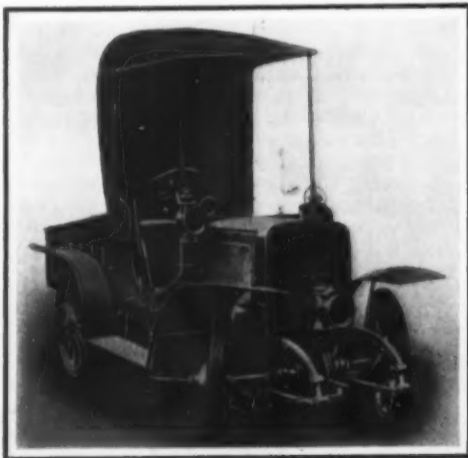
Four speeds adjusted for by a side-lever have been provided. The rear extension of the transmission shaft carries at its end a conical gearing for use in driving the chain shaft; the center of the transmission shaft, through the intermediary of conical gearings, actuates another transmission shaft, operating the four wheels, the number of turns bearing a proper ratio to that of the transmission shaft of the rear wheels. The conical gearing located in a carter communicates with the differential gear which, through the intermediary of shafts and cardan joints, actuates the two fore-steering wheels. The rear wheels are actuated by chains allowing the same reduction to be obtained in the front and the rear. The speeds are graduated according to the following ratios: 1, 1.8, 3, 4.

The arrangement above described, the same as the motor, is located on a special chassis fixed in three points to the main chassis so as to avoid any rupture of the carter in the case of momentary deformations of the chassis, such as are bound to occur on uneven roads. The clutch is a large leather-coated friction cone.

The tractor comprises a minimum of two substantial brakes, each of which is capable alone of arresting the tractor and the trailer, even on the heaviest gradients, in addition to which the trailers generally are fitted with a special brake.

The tractor is about five tons in weight, so that an adhesion of 0.4, corresponding to a tractive force of  $0.4 \times 5 \text{ tons} = 2 \text{ tons}$  can be obtained. On paved or asphalted roads this force of two tons, with gradients of 12 per cent, allows a load of 15 tons to be transported. When placing on the tractor a useful load of one ton, its tractive force is increased sufficiently to allow gradients of 15 per cent to be dealt with, which is a performance readily achieved by the motor and its transmission. It is true that these gradients which obviously are of rare occurrence in actual practice can be negotiated only with an increase in the speed of the motor at a traveling speed of 5.5 kilometers (3.42 miles) per hour.

The tractor is able at a moment's notice to be coupled to or uncoupled from any load van or other vehicle (sprinkling car, fire pump, refuse cart, etc.). As compared with the design of such cars as self-



A NOVEL AUTOMOBILE TRACTOR

Its Range With One Charge of Gasoline Is 621 Miles.

propelling vehicles, its use affords the advantage of a multitude of applications and a reduction in the wear due to the uniformity in the load on the wheels.

#### AN ARMORED STEEL BANK CAR.

The motor car bank shown in the engraving (Fig. 1) is an armored steel vehicle protected by a system of electric alarms. Should the car be attacked at any point, by drilling, wedging, cutting or annealing the steel walls, or the steel grille work protecting the windows, a powerful alarm is instantly set in motion

which can be heard at a great distance. This alarm is constructed on the same lines and principles that are in use on the largest bank and safe deposit vaults. The walls and the roof are built of steel hardened insulating material and hard wood. The body is proof against fire in garages, etc., and is also burglar proof. The car enlarges the field of bankers' operations.



FIG. 1. OFFICE END OF ARMORED MOTOR CAR BANK

Being portable, distant clients who find it inconvenient keeping touch with the bank itself, can be brought into direct personal contact with the institution through the service afforded by the car, which provides all facilities that can be found in bank offices.

It can deliver pay-rolls to factories and large sums to customers, collect heavy deposits, transport bullion, carry money and securities between branch institutions and collect and deliver valuables for safe deposit companies.

It can be used as a pay car by corporations that employ large numbers of hands scattered in sections of a city, such as street railway, electric lighting and gas companies, contractors and builders. Also by government and municipal departments as a paymaster's car.

The motor bank car body is an inclosed structure divided into two distinct sections (Fig. 2). The front for driver and passenger, the rear the banking room, whose vestibule gives privacy and protection to customers.

The banking room holds a large steel safe with a heavy bolt work system. A counter under the cashier's window contains the money drawers.

To guard against a hold-up the messenger without

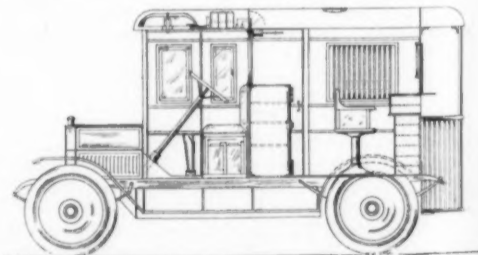


FIG. 2. SECTIONAL VIEW OF ARMORED MOTOR CAR

Driver and Passenger Room in Front; Banking Room in Rear.

leaving his seat can press a foot switch which action automatically sets the electric alarm gongs ringing. A similar device is provided in the driver's compartment beside the steering wheel.

#### Germination of Seeds in Heated Soil

WHEN soil is heated, there is formed in it a substance toxic towards the germination of seeds and the growth of plants. Seeds germinate more slowly and in smaller proportions, the higher the temperature of heating, up to 250 degrees. By exposure to air and moisture the toxic substance is destroyed. Plants grown rapidly in previously heated soil, also show the presence of a toxic substance; but after this has become decomposed, such soil, owing to increased soluble contents and altered bacterial conditions, promotes plant-growth.

# An Enormous Discharge of Dynamite

## Blasting Off the Side of a Mountain

By Ralph C. Davison

WHAT railroad men claim to be the largest single blast of dynamite ever used in railroad construction, was discharged on March 2nd at 2 P. M., by the Waltz & Reese Construction Co., on the new cut-off of the Delaware, Lackawanna & Western Railroad near Andover, N. J.

The object of this enormous blast, in which sixteen tons of dynamite was used, was to dislodge a large granite nose, part of the Roseville Mountain, which projected out over the center line of the new cut-off.

Some idea of the size of the mass which had to be removed can be gained by a glance at the cross sectional illustration of the mountain at this point.

The dimensions of the projection as shown were about 85 feet deep on the upper side, and almost grade on the lower side of the proposed new cut-off, and on the center line the distance through was about 200 feet, which in all made something over 20,000 cubic yards of rock which had to be disposed of.

The method used in dislodging this enormous amount of material was somewhat novel, for instead of drilling holes into the top of the mass and then charging these, and blasting the rock away in sections, as is usually done, it was decided that a more economical and efficient method would be to bore tunnels into the mountain at grade and then to charge these in sections, and to fire the entire mass of explosives thus placed as one single blast. A tunnel was thus driven into the nose of the rock at grade and running in for a distance of 93 feet 6 inches. Branching from this main tunnel at its far end were two lateral tunnels, one about 65 feet long and the other about 26 feet in length. About half-way in on the main tunnel two other lateral tunnels were driven, one of these being 9 feet deep and the other 10 feet deep. All of these tunnels, including the main tunnel as well, were about 5 feet in diameter as shown in the illustrations. The driving of these tunnels was no small piece of work, as they had to be cut through solid rock and as they were but 5 feet in diameter, there was not much room to work in. Therefore the blast holes had to be drilled by small compressed air drills placed on columns. These drill holes were then charged and fired, and the loose rock carried out. This work alone consumed approximately four months' time and required the services of eight men, distributed in two shifts.

After the tunnels were completed the next step was to charge them.

The method of placing the explosives is interesting. As shown in the illustrations of the plan of the moun-



ENTRANCE TO THE DYNAMITE TUNNEL

tain, the explosives were distributed at ten different points. The amount used was eleven tons of Judson powder and five tons of 60 per cent low freezing dynamite, making a total of 16 tons of dynamite.

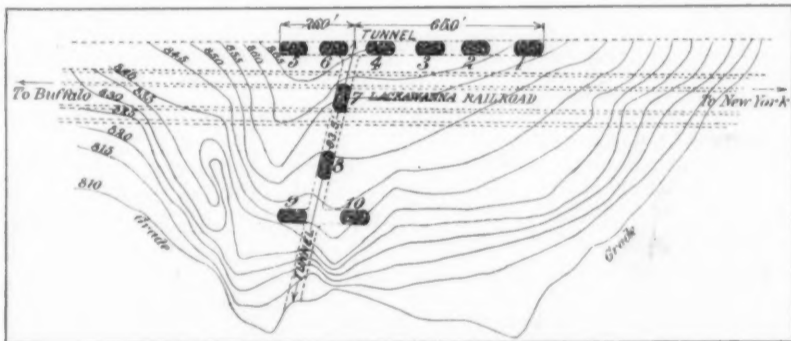
In the rear longitudinal tunnels were placed six charges of Judson powder, containing six per cent

nitro-glycerine, which produces an explosive which is slower than ordinary dynamite and which has a greater "lift." The middle section of the main tunnel was packed with two charges containing Judson and dynamite alternating with tampons of sand and stone between them. The short longitudinal tunnel near the entrance was filled with two charges of dynamite. The mouth of the tunnel was then sealed up tight with a solid wall of concrete ten feet thick. The explosives before being placed in position were all removed from their original wooden boxes, but the cartridges or sticks of dynamite were left in their paper coverings and were closely piled in position, in piles about two and one-half feet high.

The time consumed in charging and sealing the tunnel was two weeks. Low freezing dynamite was used, on this account, as there was no telling what temperature changes might have taken place in this time. If ordinary dynamite had been used at the time of the year when this blast was fired, it might have become frozen, in which event it would have been inoperative, and then the blast would have been a failure. Therefore, no chances could be taken by using ordinary dynamite, as the efficiency of the blast depended upon all of the charges being fired simultaneously. Each charge was fired by means of a special exploder containing thirty grains of fulminate of mercury, and these were set off by means of an electric circuit.

Some details in regard to the construction of these electric fuses or exploders as well as to the method of firing them, may be of interest. The electric fuses consist, as shown in the sectional illustration, of a copper shell "A," having a corrugation thrown out from the inside near the end in order to hold the sulphur cement "F" more firmly in place. The chamber "B" contains the charge of explosive, which consists largely of fulminate of mercury. The fuse wires are shown at "C." These are of copper, and are provided with an insulated covering. The ends "D" of these fuse wires are bared and enter into the fulminate of mercury as shown, where they are bridged by a small platinum wire "E," which is soldered to their bare ends. When the electric current is passed through this platinum wire it is heated to redness, and causes the fulminate of mercury to explode.

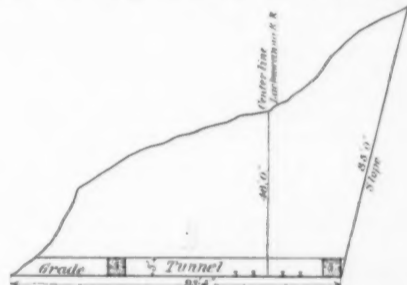
The method of using these electric fuses with dynamite cartridges is clearly shown in the illustration. The first thing to do is to take a small wooden pin, prepared for the purpose, and with this, punch a hole in the lower end of the dynamite cartridge. Into the hole thus made, the electric fuse or exploder is placed. The fuse wires are then bent back and brought along



MAP SHOWING LOCATION OF THE DYNAMITE



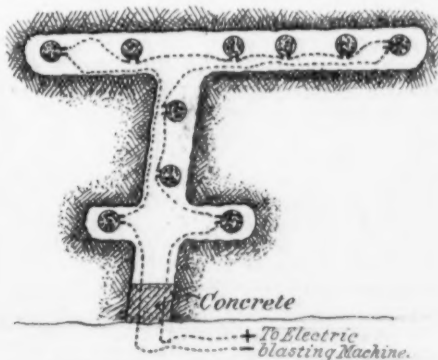
PHOTOGRAPH TAKEN AT THE INSTANT OF THE DISCHARGE



SECTION SHOWING AMOUNT OF MATERIAL TO BE BLASTED OUT



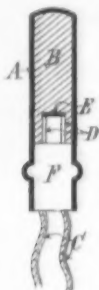
DYNAMITE CARTRIDGE, SHOWING EXPLDER



HOW THE EXPLOSIVE WAS WIRED

the outside of the cartridge and tied in position by two pieces of string as indicated in the illustration.

Dynamite cartridges with the exploders attached as explained above, were placed in each of the ten



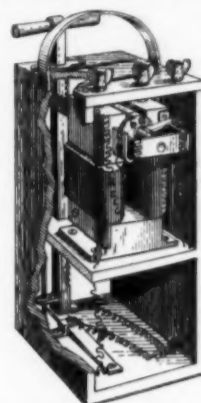
CROSS SECTION THROUGH ELECTRIC EXPLODER

charges in the tunnel. The wires from each exploder were then brought to the mouth of the tunnel and tested to see that the circuit was complete. All of these wires were then connected up in a single circuit to two wires at the mouth of the tunnel, which led to the electric battery or blasting machine. The blasting consisted of two field magnets which are energized

by the current from an armature which is rapidly revolved, by means of a quick downward stroke of the rack-bar. The contact spring, when struck by the bottom of the descending rack-bar, breaks the contact between two small platinum bearings, and in this way the current generated is thrown through the entire outside circuit and thus heats the platinum wires in the fulminate of mercury exploders, and causes them all to explode simultaneously. These exploders are most powerful, and on discharging produce a tremendous concussion which causes the dynamite to explode.

This battery was placed and operated from under a highway arch which was covered by a forty-foot embankment, located at about 400 feet from the mouth of the tunnel. As a warning, some time before the explosion was fired, steam whistles were blown, and a force of men was sent out over the highways to a distance of one-half mile in every direction to stop all teams and pedestrians. The results of the explosion were most successful, for as figured the disposition of the charges as illustrated not only loosened up the great granite mass, but as near as can be judged they dislodged something over 20,000 cubic yards of rock, breaking it up into sizes which were easy to handle, and throwing more than half of it clear of the proposed roadbed.

For the official information and illustrations used in the above description of this blast, the writer is indebted to J. G. Ray, chief engineer, and F. L. Whea-



TYPE OF MAGNETO USED

ton, engineer of construction, of the Delaware, Lackawanna & Western R. R., and to the E. I. du Pont de Nemours Powder Co.

## Poisonous Chemical Products\*

### Suggestions for the Workman

By Prof. Levin, of the University of Berlin

#### I.—Extent and Signification of Toxicology.

THE study of toxicology is intimately connected with the study of man, and constitutes, indeed, the essential feature of the study of medicine.

The use of poisons plays an immense and ever-increasing part in the daily life of humanity, not only in the small shop as well as the huge factory, but for private and personal purposes.

Ultimately considered, the energy we call toxic is merely a manifestation of chemical energy. It is probable that the muscular contraction provoked by strychnine, the deadening of nerve-centers produced by morphine, paraldehyde, or veronal, the vesicles which are formed under the influence of the products of coal-tar, the increase of the action of the left side of the heart caused by digitalin, all proceed from chemical reactions.

Empiricism is the best teacher as regards poisoning in man, since this method of study yields information impossible to obtain by experiments on animals alone. It teaches us to recognize, for example, troubles without visible symptoms, such as the innumerable interferences in the functions of the nervous system, which, while permitting a man to work, seriously lessen his bodily and mental efficiency.

How could one recognize in animals, for instance, the functional troubles caused by phenylhydrazine, which evince themselves by a general weakness, a feeling of illness, and an irregular appetite?

The science of toxicology can indeed form many *a priori* conclusions as to the effects of poisons employed in the toxic industries, but its *raison d'être* must reside in the fact that it can confirm or refute the conclusions arrived at empirically. Thus it has proved that copper, contrary to the general belief, does not produce symptoms of poisoning identical with those of lead, but may be really regarded as non-toxic.

However, no fixed rules can be laid down in toxicology, since in any given instance the toxic effect of a substance is modified by individual idiosyncrasy, and by factitious circumstances, such as the being more or less accustomed to the substance.

In its broadest significance toxicology is the study of life under those conditions which tend to produce illness. Expert knowledge of this science is slowly acquired, since besides the more obvious troubles caused by poisons there is a much larger and far more dangerous class of affections which develop quietly and slowly in the organism. The proficient toxicologist can frequently detect the first signs of troubles which would evince themselves later, and perhaps too late to be cured, such as a grave functional derangement.

Obviously, then, a knowledge of toxicology is essential in all industries where extensive use is made of chemical products, since workmen in such industries are constantly surrounded by substances endowed with biochemical energy.

Few people realize the utility of the toxic tendency of the absorption of deleterious gases and vapors, and of the inhalation or ingestion of powder or dust con-

taining alkaloids or glucosides, or of poisons of the fatty or aromatic series, which find thousands of applications in medicines or other products.

In fact it may be said in general that most substances are poisonous, and that the non-poisonous are exceptions.

Poisons are exceedingly numerous in the heterocarbocyclic series, and among these the most powerful are the toxic albuminoids. These, when formed in the body itself by an abnormal decomposition of the circulating albumen, or of the albumen of the organs themselves, occasion diseases; when they are introduced into the organism already formed, as by the venom of serpents or fishes, or by decomposed food, they may give rise to a poisoning, either acute or chronic, often difficult to distinguish from a malady. This is not surprising when we consider that what we call disease is both caused and continued by chemical action.

#### II.—Mechanism by Which Poisons Are Introduced and Removed.

Poisoning presupposes contact of the toxic matter with the tissues.

In the case of poisons which alter the tissues contact with the skin may give rise, sometimes rapidly, but more usually slowly, to more or less permanent injury. Differences of action, aside from those due to individual resistance, and to variations in intensity and duration of contact, arise from special irritating properties inherent in different groups.

Thus action on the skin, apparently identical, but differing in method of development, is occasioned by sulphuric acid, hydrofluoric acid, phenol, guayacol, the caustic alkalies, acrolein, methyl sulphate, acridine, and some species of the genus *Rhus*.

One of these poisons in contact with the skin, may under favorable circumstances, exhaust its energy thereupon without penetrating to the blood-vessels.

On the other hand such penetration may occur under certain conditions.

a.—The substance attacking the skin chemically may penetrate to the layer of blood-vessels and thus be introduced into the organism.

Volatile substances such as alcohol, ether, chloroform, acetone and carbon disulphide, dissolve the oils which protect the surface of the skin, and penetrate it, carrying with them such poisons as they may hold in solution. Hence, when handling these solutions, such as alcoholic extracts of plants containing alkaloids or glucosides, great precaution should be used, since many serious troubles are thus produced.

b.—If the skin is injured, as by substances whose action is caustic or inflammatory its protective power is destroyed. The blood-vessels and lymphatics are thus more or less exposed to poisoning or infection. Thus following a corrosion of the skin by phenic acid, poisonous quantities of this may be introduced into the blood.

c.—By a prolonged mechanical pressure tiny particles of such substances as mercury or lead may penetrate the skin and enter the blood after undergoing a chemical transformation. Many lead-workers are poisoned in this manner.

After prolonged contact with water, which dilates the skin, and under pressure, substances dissolved in the water may penetrate the deeper layers of the epidermis.

The absorption of many poisons takes place through the mucous membranes, which offer less resistance than the skin. The quantity of poison thus entering the blood increases proportionally with the extent of exposed mucous surface, with its temperature (which is above normal in irritating conditions), and with the length of contact.

The mucous membrane of a healthy organ, however, does not allow poisons to penetrate it, which fact prevents the poisoning of a person by his own urine. Certain toxics albuminoids and pathogenic bacteria cannot enter unless there is a lesion of the epithelium, which may be produced either chemically or mechanically.

The entrance of poisons through the mucous membrane naturally often occurs in the mouth and still oftener in the stomach and intestines.

Poisons difficult to dissolve in a test tube are dissolved by these organs in a manner often inexplicable. Thus are produced poisonings by means of substances in the form of powder, whether mineral, vegetable, or synthetic. Such poisonings occur more readily and more rapidly when the mucous membrane is not in a normal state, and especially when its protective layer is injured.

It is difficult to tell what part diffusion plays in the passage into the blood of substances made soluble by a mucous membrane. I consider probable the hypothesis that the blood or lymph in circulating creates a suction in the neighborhood of the vessel which causes the entrance of foreign products. The richer in blood the region of the body concerned, the more quick and complete this entrance. . . .

The question next arises what becomes of the poisons absorbed?

Aside from the injuries caused, and the decomposition into non-toxic products, two hypotheses remain to be considered—excretion and precipitation or deposit.

The human body possesses the faculty of throwing off rapidly, and by the most convenient means, all foreign and non-assimilable chemical substances either developed within it or introduced from without.

The glands ordinarily serve this purpose. In general, toxic substances are eliminated with a rapidity directly proportional with the size of the glands, i. e., with the quantity of liquid which they secrete and with their temperature. The kidneys and numerous intestinal glands are of the first importance and then the salivary glands and those of the skin.

Unless too great a quantity of the poison has been absorbed the body can thus ordinarily disembarass itself within a brief time.

But in some cases poisons after a single absorption may remain deposited in the body a longer or shorter time without sensibly affecting the health, or may provoke intermittent troubles due to a renewed passage of the deposited matter into the circulation.

Sometimes, too, following an acute poisoning, and after the poison has been eliminated, new sufferings

\* Abstracted from an address delivered before the Fachgruppe für medizinisch-pharmazeutische Chem.

arise, often of long duration. Carbon monoxide may be cited as an example of this. After the period of acute poisoning, and when the combination with the hemoglobin has been forcibly destroyed by respiration and has been eliminated, symptoms of the malady reappear. These are probably due to an imperfect restoration of the functions originally disturbed by the vitiated blood.

Every living organism expends a certain amount of energy in combating the ills which affect it. This spontaneous reaction always takes place in some measure, but ceases when the strength of the chemical reaction of the poison dominates the vital energy.

This is what happens in the case of wounds which eat into the flesh instead of healing; it is because the decomposition which takes place constantly produces new toxic products.

### III.—Influence of Individuality on Occurrence and Development of Poisonings.

Among both animals and men special characteristics are found which manifest themselves in variations of the normal physical functions. There is hardly an organ of the body which functions in precisely the same manner in different individuals, whether the brain, the spinal cord, the glands, the nutritive organs, or the muscles.

These physiological differences of action are comparable with the differences of reaction produced by the operation of forces outside the body. No biological fact from the earliest times to the present has so astonished both physicians and laymen as this, that the causes of maladies, including poisons, act so differently in men and in animals. In the remotest epochs it was observed that one man might be slain by a wound less serious than that from which another man quickly recovered and that certain animals might swallow large quantities of poisonous plants which would seriously affect or prove fatal to other animals or men.

Galen, the master-mind of medicine, whose principles were followed for more than ten centuries, made observations concerning the influence of habit with reference to resistance of injurious influences.

Moreover, it is a well-known fact that certain individuals are immune to, or but slightly affected by poisons generally harmful. And this holds good from the lowest to the highest forms of animal life.

Why is it that the *Tylenchus tritici* which attacks grain can live and even develop admirably in glycerine, and that it is not incommoded by morphine, belladonna, atropine, strychnine, or curare?

Why are ducks, pigeons and poultry not poisoned by the injection of opium? How is it that mice can swallow with impunity *Iolum temulentum*, and that rabbits can eat considerable quantities of the leaves of bay and belladonna? Why can rabbits support doses of many grains of cocaine or hasheesh?

It is possible that in some cases symptoms have appeared which we have failed to recognize, but why then should the same poison produce visible symptoms in other animals?

Moreover, the problem of the greater or less sensibility of different men to poisons, even when not ha-

bituated, remains as much an enigma to us as to our ancestors.

For example, most persons have the skin affected, often lastingly, by the touch of *Rhus toxicocendron*, or even by particles of it blown through the air, while some people are able to handle it, crush it, and even receive the juice of it in the eyes without harm.

While modern theorists offer various explanations of these facts none are really satisfactory, since all can be refuted.

The theory of antitoxins does not explain this immunity, whether innate or acquired by habit or other circumstances. This theory is, in fact, purely philosophic and non-demonstrable.

We do not know a single poison which when introduced voluntarily during an extended period into the organism of an animal develops in the blood a contra-poison capable of rendering the poison inoffensive or of acting preventively by making a toxic action impossible.

It may be demonstrated, also, that in animals which, like the hedgehog, possess a high degree of resistance, this property does not reside in their blood, and that their blood-serum when transferred to other animals, does not preserve these from a poison which the hedgehog escapes.

Serotherapeutics cannot prevent either alkaloids or glucosides, or those well-known poisons which either attack the blood or are toxic in some other manner, or albuminoids like abrine or serpent-venom, from exerting their toxic power.

It is, then, impossible, to explain thus the differing resistance of different individuals to poisons.

There remains the hypothesis that the constitution of the organs in certain individuals must be of special nature or idiosyncrasy, rendering them either very resistant, or exceedingly susceptible to certain poisons. This varying constitution is what the ancients meant by what they called the vital force of the individual.

### IV.—Symptoms of Poisoning.

The symptoms of poisoning are as numerous as those of the other ills which attack mankind.

All the organs, and all the functions of the human body may be affected, and the disturbance may extend to parts of the organism not directly touched.

The typical fundamental action is due to the poison, while the variations come from the constitution and conditions of the individual.

The trouble may appear immediately following the action of the poison, or not till after a period of incubation of variable length. The first is the most frequent, but I am able to deny, after long observation and experiment, the validity of the wide-spread opinion that poisons differ in general from infectious diseases by the lack of an incubation period.

Thus I have demonstrated a tardy action of carbon monoxide, which usually causes at once an alteration of the blood through the respiration.

Also *Rhus toxicocendron* in certain cases does not cause the irritation of the skin till after the lapse of several days. Even after the injection of poisons which cause grave general troubles, as phosphorous, the first symptoms may not appear till after several hours, or even a day or two.

These incubations may depend on the slight solubility of the poison, the state of fullness of the stomach, the rapidity of the passage through the pylorus into the intestine, or a variety of other circumstances.

It is impossible to calculate the time of the appearance of symptoms after the repeated absorption of small quantities of poison, because the organism defends itself as much as possible by the expulsion of the poison.

Those who handle poisons constantly should note carefully all symptoms of ill-feeling, and consider the possibility of their connection with the poison. This need not lead to hypochondriac anxiety, but merely to carefulness.

Thus many a trouble might be arrested in its early stages, where ignorant neglect would allow of its becoming so firmly established as to be incurable—and this is true of such various affections as those of the heart, lungs, nervous system, bladder and kidneys, or skin.

### V.—Remedies.

Since poisons cannot be eliminated from the world, man must constantly come in contact with them. Consequently we should endeavor to prevent or reduce to the minimum their possible ill-effects.

It is my profound conviction that the best means of accomplishing this lies in a thorough knowledge of their action.

I have seen a hundred times the careless handling of poisons whose absorption in small quantities might lead to grave results, and in nearly all cases the manipulation might have been different. And it was not always mere workmen who thus courted danger, but often their superiors in knowledge.

If the principal cause of accident is ignorance, the second is recklessness. Men proud of their strength take risks defiantly and are amazed when they finally fall victims to their own folly.

Whoever is in any way exposed to poisons should take pains to acquire a definite knowledge of their nature and effects.

Technology has of late made great strides in the development of protective methods in factories where poisons are manufactured or used.

By local air currents toxic powders are removed, and even the enormous quantities of nitrous vapors disengaged in some shops by the attack of thousands of kilograms of copper alloy are removed.

I know that smaller shops cannot afford the expense of such installations, but there are numerous methods, more or less costly, for individual protection, such as respirators with special devices for toxic powders; gloves for handling substances which attack the skin, or, like potassium cyanide, penetrate it; spectacles for those who work in caustic products which throw off gas or vapors injurious to the eyes.

Other measures consist in good ventilation, the washing of work-tables several times per day, and above all the laying of dust by smearing the ground with westrumite or some similar substance.

As my final word, let me reiterate: Learn and propagate the principles of toxicology and you will protect both yourselves and others.

### Some Technical Features of Telephone Engineering\*

By R. M. FERRIS.

#### I. Extension of Equipment.

In my remarks I shall endeavor to give you a general idea of the nature of the work required of technical men in a large telephone company. I think the best way for me to do this is to explain briefly the nature of some of the larger problems which the technical men are constantly working on.

The American Telephone and Telegraph Company is the company commonly known as the Bell Telephone Company, owning what is known as the Bell system throughout the United States. The Bell company itself operates the long distance lines and maintains central departments dealing with engineering and other matters to develop new methods and new apparatus, to establish standards, and to act as consulting engineers for the other companies.

The very rapid advances which are now being made in many directions in the telephone art and the very large additions which all of the companies are making to their plants necessarily impose very serious responsibilities on the technical men in the business who are responsible for preparing the plans for the proper expenditure of very large sums of money and then seeing that the money is properly expended in accordance with the plans. Looked at from a purely scientific point of view, the importance of a given class of work would be independent of the amount of money, the expenditure of which was dependent upon it. From an engineering point of view, however, the

amount of money to be expended has a great deal to do with the importance of the work. No matter how interesting from a scientific point of view a given question may be, from an engineering point of view it is of little or no importance if only the expenditure of a small amount of money is dependent upon it. On the other hand, if a method of expending large amounts of money is dependent upon the decision obtained on a certain physical question, then this question becomes one of great engineering importance. In the telephone business it is the combination of the large amount of money expended and the interesting scientific nature of the questions which must be solved in connection with its proper expenditure that make this work so absorbing to those engaged in it. The following I think will be sufficient to illustrate the nature of some of this work.

In order to establish telephone service in any large city, such as New York, or Brooklyn, or Buffalo, it is necessary of course to have one or more large central offices containing the telephone switchboards. The telephone lines throughout most of the city must be carried underground in telephone cables, which must be placed in telephone subways.

Before any actual construction of the plant can be intelligently done it is necessary to know whether there should be one central office in the city or whether there should be more than one; where the office or offices should be located; how large the various switchboards should be; and of what type they should be. With reference to the subways and cables, it is necessary to know in what streets they shall be run; how large the subway system should be built; the types of cables that should be used; and many other points.

The solution of a problem such as this for any large city is a very complex engineering question, and it is to the solution of this problem as a whole or to the solution of various parts of it, that we have given the name of "Fundamental Plan."

The method of making a fundamental plan is briefly as follows: It has been determined that plans should be made for a period of about fifteen years, and estimates of the number of subscribers' lines which we will have in a city at the end of that period are made and a distribution of these lines laid out in the various sections of the city, the distribution being based on the character of the various sections and their possibilities of development as can be best foreseen. After this has been done, various arrangements of central offices are laid out—say an arrangement of five, ten, and fifteen offices. The total annual costs of each of these arrangements is determined, and the most economical arrangement selected.

The fundamental plan indicates what arrangement of offices it will be most economical to have at the end of the period in question; it does not indicate when or in what order the offices should be established, and there is a great deal of engineering required in the proper application of this plan in order that we may not only have a proper arrangement of offices at the end of the period in question, but that from year to year, as the plant grows, the number and arrangement of offices should be proper for the conditions existing at that time. For example, in case a central office building is becoming congested, we have to consider whether it would be more economical—

1. To enlarge that building;
2. To take care of the growth by transferring a portion of the district to another district; or

\* Abstract of lectures before the Senior Class in Electrical Engineering, April, 1910.

### 3. To put up a new building and switchboard.

Besides these, there are often other measures which can be followed.

If we find that it is economical to establish a new central office building, the amount of space required for central office purposes and for other purposes is determined, and the most economical floor plan for such a building and the size and shape of lot necessary for its accommodation are next studied and determined. This information having been given to the business management, a search for real estate is made in the vicinity of the telephonic center as determined by the fundamental plan, and prices obtained on a number of sites located in the vicinity. After excluding those sites which are not of suitable size or shape, the remaining sites are considered and the asking price of the property weighed up against the costs for subways and cables which costs are of course different for each site and which becomes greater and greater as the sites are located more distant from the telephonic centers, this center being by definition the point at which the subway and cable costs are a minimum.

Having determined the most economical site and this site having been purchased, the next point to be settled is to prepare the preliminary floor plans of the building which are to serve the architect as the basis for his work. The preparation of these preliminary plans involves working out in detail the design of the telephone switchboard in order to determine the amount of equipment of various classes to be provided. It involves a careful consideration of the matter of bringing the underground cables into the building and the arrangements through the building in order that such cables should be brought up to the terminal room, and a careful consideration of the location of the various parts of the telephone apparatus in order that such arrangements might be the most economical and convenient.

Having completed these preliminary plans and indicated not only the central office arrangements but also the arrangements for other purposes, the plans are placed in the hands of the architect who prepares the detailed plans and specifications. The architect's plans and specifications are of course checked and then the contract for the building is let.

Soon after the building is started the detailed plans and specifications for the telephone switchboard must be written and sent to the contractor who manufactures these switchboards. In connection with the design of the switchboard, much study of an engineering nature is required to determine what constitute desirable and economical operating methods. Our methods of handling business are not determined by the types of apparatus which we build, but the converse is true. The proper methods are first determined and then, as far as physical conditions will permit, apparatus is designed to meet those methods.

In addition to the work described above, the study and development of new methods of construction in what we call the "outside plant," which consists of underground conduits, underground and over-head cables, pole lines, etc., involves many engineering problems, in order to ascertain the most economical types of construction to meet various conditions. Much interesting work has been done recently with reference to timber preservation, design of concrete poles and other fixtures, design of submarine cables to meet peculiar telephone conditions, etc.

The efficiency of transmission lines of apparatus is most important, and underlies the design of almost every part of the telephone plant. In power transmission work, it is necessary that considerable amounts of power be transmitted over lines with a small loss of power in the lines themselves. In telephone work it is necessary to transmit small amounts of power much greater distances, and it is necessary that there shall be, not only a small loss in the amplitude of the wave, but that the wave form itself shall not be distorted. Important studies are made to see that a proper grade of transmission is obtained in the most economical manner.

I think enough has been said in the foregoing to indicate that the telephone companies are constantly having to meet intricate technical questions on which important engineering work is required.

### II. Extension of Commercial Range of Transmission.

By DR. JEWETT.

With the growth of the Western sections of the country there has come an increasing demand for the transmission of speech to distances greater than 1,000 miles and a problem has arisen quite as difficult as that confronting the engineer who transmits large quantities of electrical power over long distances. In certain ways the problem is even more complicated since the transmission must be affected without serious loss in intensity and also without appreciable change in the form of electrical wave transmitted. At present the telephone companies are preparing to meet the problem of extending the limits of satisfactory com-

mmercial operation from the Atlantic coast cities to points beyond the Mississippi Valley, which is now the western limit.

To effect this improvement involves the whole telephone plant in the region affected. This is evident from a consideration of the system of connections involved when a subscriber in New York city is talking with one in Chicago. The scheme of connections is indicated systematically in Fig. 1.

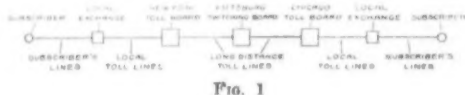


Fig. 1

The connections are as follows: New York.

- From subscriber's instrument to the local exchange board;
- From local exchange to outgoing toll board, over toll lines;
- Over long distance toll lines to switching board in Pittsburg;
- From Pittsburg over toll lines to Chicago toll board;
- From Chicago toll board to local exchange;
- From local exchange to subscriber in Chicago.

Thus, there are five switching points between the two subscribers, and at every switching point the resistances of the switching apparatus add to that of the long connecting lines and lower the efficiency of transmission of the talking currents.

Another feature which is rendering long distance transmission more difficult is the growing necessity of putting the telephone lines under ground, for greater and greater distances as the municipalities passed through extend their borders. As the capacity of underground cables is far greater than that of aerial lines the difficulties of transmission are increased by this change, or the effective distance of transmission is increased.

While there has been a steady advance in the quality of instruments used, this growth has not kept pace with the substitution of cables for overhead wires, so that other means must be relied upon for improvement and extension of service.

The greatest aid thus far discovered is the "loading" system devised by Prof. Puppin who discovered that if induction coils be placed at intervals along the telephone cables, the capacity of the lines may be compensated for and the distance of possible transmission greatly extended. Thus the efficiency of transmission is increased as much as two to three times that of the same cables without loading.

An added effect can of course be obtained by lowering the resistance of the lines by increase in area of wires used. By this means the transmission losses, due to the switching apparatus interposed in long distance work, may be made up by the use of more copper in the lines joining switching points. It becomes an interesting problem in finance to figure what changes will affect the desired increase in commercial



Fig. 2

range of speech transmission with the greatest returns for the money invested. This problem becomes of especial interest when it is desired to add the necessary apparatus so that the lines may be used for the greatest number of messages in a given time.

### By-products of the Telephone Business.

It is common practice to arrange lines to transmit simultaneously telegraph and telephone messages. More than this, by properly combining the lines, more than one telegraph message may be sent at the same time, and it is even possible for the wires to transmit more than one telephone message at one time. Thus, in addition to loading the lines, the telephone engineer plans to increase its efficiency by arranging the line to accommodate both kinds of service. With two pairs of wires between say, New York and Pittsburg, it is possible to transmit, at the same time, three telephone messages and eight telegraph messages.

The method by which this is accomplished is shown in Fig. 2. At the mid-points of the transformers, *T*, taps are taken off at each end of the system and carried to receiving apparatus. As indicated by the arrows, talking currents which come equally on both wires of, say, line 2, pass in opposite directions through the upper and lower halves of the transformer and so neutralize one another so far as their effect in the secondary of this transformer is concerned, so that they do not affect the receiving apparatus of line 2. They are, however, received in the apparatus of line

3, whence they pass through the transformer on line 1 without being there detected, and return to the sending station along both wires of line 1. Thus it is possible to send telephonic messages along line 1, line 2 and this "phantom" line.

If now, condensers be inserted at *C*, in each of the four wires, it is possible to take off to telegraphic apparatus using one wire of the telephone system and the ground for return. The condenser allows the high frequency talking currents (as high as 2,000 cycles per second) to pass unimpeded, but prevent the passage of the telegraph currents. The telegraph apparatus tapped in beyond *C* has an inductance coil *L*, which prevents the passage of the high frequency talking currents but does not affect the telegraphic impulse. By the well known system of "duplexing" a line two telegraphic messages can be sent over each of the four wires at the same time so that we have the three telephone and eight telegraph messages at one time.—*The Sibley Journal of Engineering*.

### Handy Center Indicating Tool

A CENTER indicating tool for locating the prick-punched centers of work true with the machine spindle on a boring mill or a milling machine, may be made as shown in the accompanying line engraving. The shank of the tool may be tapered or straight to be held in a chuck. The ball shown at the front end of the hole in the shank is  $\frac{3}{4}$  inch in diameter, is hardened, and has a hole drilled through the center in which the pointer is inserted. When using the tool, the shank is inserted in the spindle of the machine, and the end of the pointer is placed in the center hole of the work to be centered. After having been thus located, the pointer is moved back out of the prick-punch hole in the work and the machine started up. If the end of the pointer wiggles or moves about in a circle, it indicates that the center of the work is not in line with the axis of the spindle. The cap *A* in the front of the hole is driven into the hole in the shank, and holds the ball in place. On the other side a bushing *B* is pressed up against the ball by the spring *D*, so that whenever the pointer is set out of line with the spindle, it will



HANDY CENTER INDICATING TOOL.

be held in this position by the friction between the bushing, ball and cap, caused by the pressure of the spring. There is a small hole through the entire shank to permit the pointer to be driven out of the ball, if required, for repointing.—*Machinery*.

### Examples of Osmotic Growths

OSMOTIC growths are mineral productions simulating the forms of organic life. They are obtained by sowing a mineral seed or nucleus in a concentrated inorganic mother liquor. The nucleus reacts with the liquid to form an insoluble gelatinous precipitate at the surface of contact. This semi-permeable extensible membrane is distended by the osmotic pressure within, and grows by a process of intussusception, branching and putting forth terminal organs as it reaches a solution of lesser concentration.

Osmotic growths were first described by Prof. S. Leduc in his work on the "Mechanism of Life."

Some interesting examples of these osmotic growths were exhibited by Dr. Deane Butcher before the recent Royal Society Conversazione.

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